Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

FOR ALL POWER ENGINEERS • STEAM, ELECTRICITY AND ALL OTHER POWER ENGINEERING SERVICES

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The PRACTICAL ENGINEER and ELECTRICIAN

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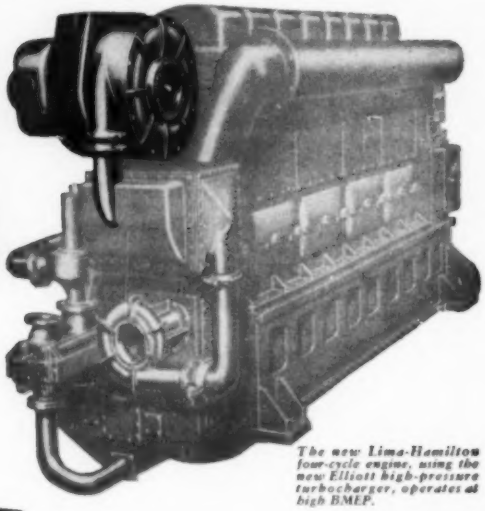
SEPTEMBER
1950

TECHNICAL PUBLISHING COMPANY • CHICAGO, ILLINOIS

BIG NEWS FOR

The new Elliott turbocharger is of simplified design, resulting in increased sturdiness.



The new Lima-Hamilton four-cycle engine, using the new Elliott high-pressure turbocharger, operates at high B.M.E.P.

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TYPE H (FOR HIGH PRESSURE)

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M-102

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● **LOAD ON BOILER CUT BY 75 HP** by trapping with Armstrongs, says Chief Engineer of large midwestern hospital.

● **30°-40° TEMPERATURE INCREASE** on 8-roll ironer after unit trapping with Armstrongs, reports large eastern laundry.

● **STARCH DRYER HEAT-UP TIME CUT 2-3 HOURS** after retrapping with Armstrongs, says Canadian plant engineer.

● **125 HP BOILER NOT NEEDED** — 80 HP boiler does the job since Armstrong traps were installed in a chemical plant in Iowa.

● **50% SAVINGS IN TRAP MAINTENANCE LABOR COSTS** since installing Armstrongs at midwest agriculture machinery plant.

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Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

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September 1950

VOLUME 54—NUMBER 9

Notes on This Issue

How to Select Centrifugal Boiler Feed Pumps

As power plant pressures and temperatures have gradually risen to their present high values, it has become more and more important to develop and use the proper feed pumps correctly to fit the conditions of the cycle. This article tells the power engineer what he has to do to accomplish this.

Fire Your Gas Safely

Because of the increasing availability of gas and oil in many parts of the country, caused by the extension of the pipe lines, a great many power engineers are interested today in burning gas or oil instead of coal, or in the case of new plants, designing them specifically to burn gas with coal or oil standby or the reverse.

If for one reason or another a plant has decided to burn gas, it must take certain precautions because gas must be handled in a different way from coal or even oil. It is true that there have not been very many bad accidents in gas-burning power boilers and that is due to certain precautions that everybody should take and most everybody does take. When these precautions are taken, gas forms a very fine boiler fuel.

Various devices for preventing explosions in the gas-fired furnace and various methods of operation to keep the gas-air mixture just right are discussed in this article.

Insulation Methods for Steam-electric Power Units

This fine two-page article by the superintendent of Miami Fort Station (see May issue of POWER ENGINEERING for complete description of the Station) tells in detail how the new steam-electric generating units at Miami Fort and West End stations in Cincinnati are insulated and what materials are used.

Hot Zeolite Softening

During the last few years the ion exchange method of water treatment has come into prominence and, where its costs can be justified, it has proved highly successful.

There are many instances, where intermediate boiler pressures are in use, where extreme high purity water is not required and in these cases the two-stage hot process method of treatment, because of its lower cost, still has many attractions.

In recent years a combination of these two methods has evolved—the so-called hot zeolite process which uses a styrene-base resin zeolite softener as second-stage treatment following a first-stage hot process precipitation softener.

It is this method that Mr. Calise considers in this article. While this combination system has been used in Europe for a number of years and installations of it have been in operation in this country, in general it is not too well known.

For this reason, this comprehensive description of the method will be welcomed by all operating engineers and designers of water treatment equipment.

Dual-Fuel Diesel Cuts Municipal Power Costs

This short article tells how this 1440-hp Superior Dual-Fuel Diesel generating unit was installed at the Ames, Iowa, Municipal plant in 1947 to furnish power while a new steam plant was being built.

It proved so successful and economical that now that the steam plant is in operation this Diesel unit is retained to supply supplemental power at time of peak load.

Dow's South Power Station—Latest Thing in Industrial Power

This article, including a complete list of equipment, describes the new and very advanced power plant just put into operation last month by Dow Chemical Company at Midland. This is is the fourth large power plant installed there to serve the tremendous chemical processing operations.

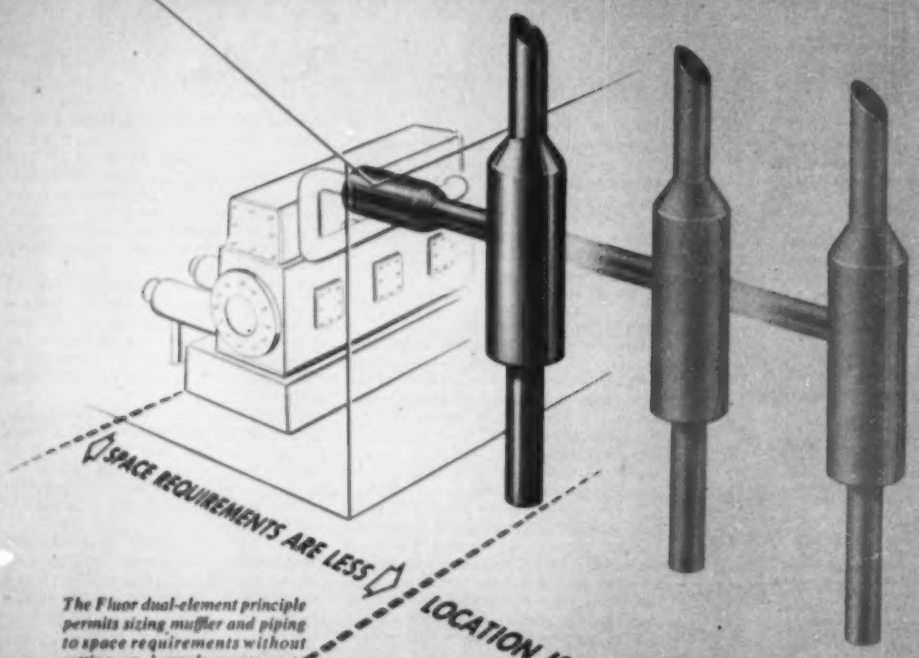
See for yourself...

the installation advantages of a FLUOR SERIES "D" MUFFLER SYSTEM

NO LONGER is ultimate muffling efficiency dependent upon trial-and-error locating of exhaust piping. With the Fluor Series "D," exhaust piping can be of *smaller* diameter, location of outside exhaust chamber *flexible* without affecting pressure drop or noise attenuation and pulsation reduction efficiency.

The reason lies in the unique dual-element design of this *muffler system*. Work is started on pulsative exhaust gases *at* the engine—noise and pulsation reflections are virtually eliminated *at* their source. The Fluor Series "D" Muffler is a *system* that incorporates *two* muffling elements—a primary element located in the immediate proximity of the engine and a secondary element located *at any desired spot* outside the engine room.

The Fluor Series "D" Muffler System is the answer to your muffling problems. In addition to installation flexibility it provides the highest muffling efficiency obtainable—*at a cost competitive with conventional mufflers.*



The Fluor dual-element principle permits sizing muffler and piping to space requirements without setting up hazards common to single-element mufflers.

All elements, including interconnecting piping, are engineered to a minimum in diameter.

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ENGINEERS' PREVIEW

TRANSFORMING old railroad rails into useful products, such as fence posts, bedsteads, clothes poles, wheelbarrow handles and playground equipment, keeps about 20 mills busy in the United States and Canada, says American Iron and Steel Institute. The old rails are not remelted. They are heated to rolling temperature in a furnace and then are sliced into three parts—the head of the rail; the web, namely the middle part of the rail; and the flange or base of the rail. Each of these sections is then rolled to the required size and shape. Concrete reinforcing bars, structural tubing and light rails are the principal products rolled. About 700,000 tons of finished product, mostly bars, are rolled each year from old material such as rails, axles and other products suitable for conversion by hot rolling without remelting. Rails have been used as a source of material for re-rolling since about 1860.

★ ★ ★

AUTOMOBILE HORNS can be made less raucus and yet just as loud, says an acoustics expert at Armour Research Foundation of Illinois Institute of Technology. The formula: cut out some of the high notes.

Daniel Callaway, associate physicist at the Foundation, describes a two-month study of horns, sponsored by the Foundation as part of a general survey of all city noises, which led to his assertion that the higher pitches of horn blasts ought to be removed. He said it could be done at low cost, with the saving on nerves more than making up the difference.

Three types of car horns were investigated: 1.—electrically operated trumpet, made up in pairs and harmonically tuned. These are found on most new cars. 2.—compressed air, the long, deluxe models sometimes custom installed on expensive cars. 3.—vibrating diaphragm, or "beep-beep" type, the least expensive.

Models of all three types got the same treatment and analysis, both in the laboratory and the field. The horns ranged from 100 to 115 decibels at 10 ft, Callaway reported, which is "very loud," since traffic measures from 70 to 90 decibels on the sound meter.

Callaway would cut out all sound above 1200 cycles per second, leaving the lower frequencies as they are. He did this electronically on a recording of a horn blast and reported improvement.

Work on a special horn using only the frequencies below 1200 cycles per second is going on at the Foundation.

"The worst thing about automobile horns is how people use them," admitted Callaway. "We can't solve that in the laboratory."

★ ★ ★

NEW INSTRUMENT designed to facilitate observation and photography of air flow phenomena has been announced by General Electric's Special Products Division. The instrument known as the "Schlieren Light Source" is a self-contained unit housing power supply, control circuits, lamps, and optical system. It furnishes both continuous and high intensity flash illumination.

The Schlieren system operates on the principle that a change in air pressure or temperature produces a change in the air's light bending properties. (Like the familiar shimmer of air above a heated road in the summer time.)

A PROJECT like Grand Coulee Dam is so spectacular in its physical size that the public is seldom aware of many of the detailed problems to be solved as the plant goes into operation. The public is properly astounded at the tremendous 150,000-hp hydraulic turbine generators, the spectacular spillway, and is also frequently surprised to learn that one of the principal functions of Coulee Dam will be to supply irrigation water to a tremendous area and that this water is being pumped by gigantic pumps each having a capacity of 1600 cu ft per second and each driven by a 65,000-hp motor.

However, here are a few of the details that go along with the big hydroelectric generating and pumping units. For example, the tempo of the flood control "hold-back" behind the dam has been stepped up to keep pace with the rising spring run-off. In June the level of the Franklin D. Roosevelt Lake was raised by a foot on June 16 and was raised another 0.9 foot within the next 24 hours. The first tentative schedule called for a holdback of 5 ft in 10 days, but this was later boosted to almost 7 ft in 9 days. This would equal a flood one foot deep over a half million acres of the Columbia Basin. If the maximum holdback were required, Grand Coulee Dam would have stored enough water above the normal reservoir level to flood the entire state of Rhode Island with water a foot and one-half deep.

Here's another detail. Crowded living conditions for government employees in 25 single-bedroom homes of Coulee Dam will be alleviated by the building of an additional bedroom to each of the 25 units, but it may take 300 days to complete all of these.

Here's another. Ray M. Moorhead, materials engineer at the Dam, has been rewarded for an invention that promises to lick the age-old contractor's problem of connecting circular pipe to concrete. The device employs two eyebolts and a hemisphere to cinch the concrete or tile pipe against the form which is prepared for concrete pouring. It saved up to three hours in each installation at the Yakima Project, where the idea was first developed.

In the Grand Coulee Gorge an estimated 20,000 acres must be cleared of sagebrush preparatory to the first placing of water in the storage reservoir in the summer of 1951. This is being done first by spraying by airplanes, using a combination of 2 4-D and 245-T, mixed with an aromatic oil. In addition to dusting by plane, the dusted sagebrush must then be burned under proper conditions of wind and humidity. Yet there are still a great many things in clearing this land that can be done only by heavy ground equipment—for example, clearing out fence posts, barbed wire and so on. It is most important, however, that weeds be killed before water is flooded into the upper Grand Coulee, otherwise the flow might sow the seeds over a vast area of the basin through irrigation canals. The obstructions of the reservoir must be removed, lest they clog the irrigation channels.

Finally, aluminum crest railings with lighting for the Grand Coulee Dam will cost $195,003.08 for the material and $67,109.50 for installation. The railings, approximately 4000 ft long, will have built-in lighting similar to the railings installed at Shasta Dam in California. Don't forget those railings include all the lighting equipment, are installed outdoors and the lighting must operate under all weather conditions.

WORLD'S LARGEST reheat boiler to generate steam for electricity has been purchased by Consolidated Edison Co. from The Babcock & Wilcox Co. The utility company will build a new station in Astoria, Queens, to house the giant boiler and other related equipment for generating electricity, and says the first unit installed will cost $25,000,000. The new station and equipment is a part of Consolidated Edison's half-a-billion dollar expansion program and is the first new station to be built by the company since 1926.

The new boiler will be as high as a 14-story building and will produce 1,200,000 lb of steam per hour. The boiler will initially burn oil, with provision for future installation of coal-burning equipment. It will develop steam temperatures of 1000 F.

★ ★ ★

A MACHINE which in a 25-ft square room will reproduce the electric power network of all Illinois outside Chicago, yet use less current than the oven of an electric stove, is to be built at the University of Illinois.

Problems it can solve include: where to place new power lines for greatest efficiency; how to prepare for emergencies when a line may be interrupted and others have to take over the load; what to do in a city to meet overload troubles; what facilities to build to provide for a new heavy-power industry; and many others.

It will save millions of dollars for the power industry of the state. In one hour engineers will learn from it more than from three months of complicated calculations; and in some cases get answers which no amount of calculation could provide.

It will be used for service to the power industry, for teaching, and for research in both electrical and other fields. It will cost approximately $50,000 the major part of which is being provided by three power companies operating in the state. This is the latest of many projects in which power companies of Illinois have cooperated with the University.

The machine will be called a "10,000-cycle A.C. Network Analyzer." Plans for it have been made, many parts ordered, and work on remodeling the room for the machine has begun. It will be operating by early fall of 1951.

Providing funds for the machine are the Illinois Power Co. of Decatur, Central Illinois Public Service Co. of Springfield, and Union Electric Co. of St. Louis. In return, these companies will have use of the machine for up to 13 weeks each year. The Sangamo Electric Co. of Springfield is giving the 6,000 condensers for the machine.

Illinois power companies not in the fund-providing group also may use the machine, but will pay a slightly higher operating charge than that made to the sponsors.

★ ★ ★

LARGEST and most powerful "atomic furnace" in the country began operating August 22, 1950 at Brookhaven National Laboratory, Upton, N. Y. It is an atomic research reactor, designed for production of neutrons by nuclear fission of uranium, for use in research on the structure of matter, on production of radioactive fission products, on research in metallurgy, biology and so on. The reactor is a huge graphite-uranium pile, which, at its designed power level, will develop heat at a rate of 30,000 kw. It was built to the specifications of the Brookhaven reactor staff and the AEC by H. K. Ferguson Co. Further details of this important development in our nation's atomic energy program will be given in a future issue of our companion magazine ATOMICS.

CURIOUS to find out how good the Russians are in science, are you? Well, perhaps you can find out in this way: For the benefit of highly-specialized laboratories and individual chemists, Consultants Bureau, 152 W. 42nd St., New York 1, will provide copies of the English translation of any article in Russian from the *Journal of General Chemistry of the USSR*, at $5 per article, and from the *Journal of Applied Chemistry of the USSR*, at $7.50 per article. Orders for copies of the translations of individual articles should cite title, author, and original Russian pagination of the article desired. Payment at the rate cited above should accompany order. (These rates apply regardless of the length of the individual article.)

★ ★ ★

TERRIFIC pressure in the international rocket race to keep coming up with the latest word in rocket engine design for piloted aircraft and guided missiles is pushing out new engines in this country before yesterday's engines have been subjected to enough field experience to show up any bugs they might have. It is not uncommon for engineers building rocket engines to hit a snag and have to stop and do a little fundamental research on their own.

These facts were disclosed at the spring meeting of the ASME by Harry B. Horne, Jr., assistant to the executive vice president and general manager of Reaction Motors, Inc. "The rocket engine of today's design suffers from a distinct lack of field operational experience except in a very few cases," Mr. Horne said.

"This condition has been brought about by restriction of funds for the procurement and operational testing of missiles and aircraft powered by liquid rocket engines.

"If it were necessary to make a choice of absolute values, it would be difficult to say which is the wiser course in the expenditure of development funds: to keep reaching for higher and higher degrees of development through the route of new items, or to develop an existing item more thoroughly," he said. "It should not be necessary to choose; both programs are necessary for proper balance."

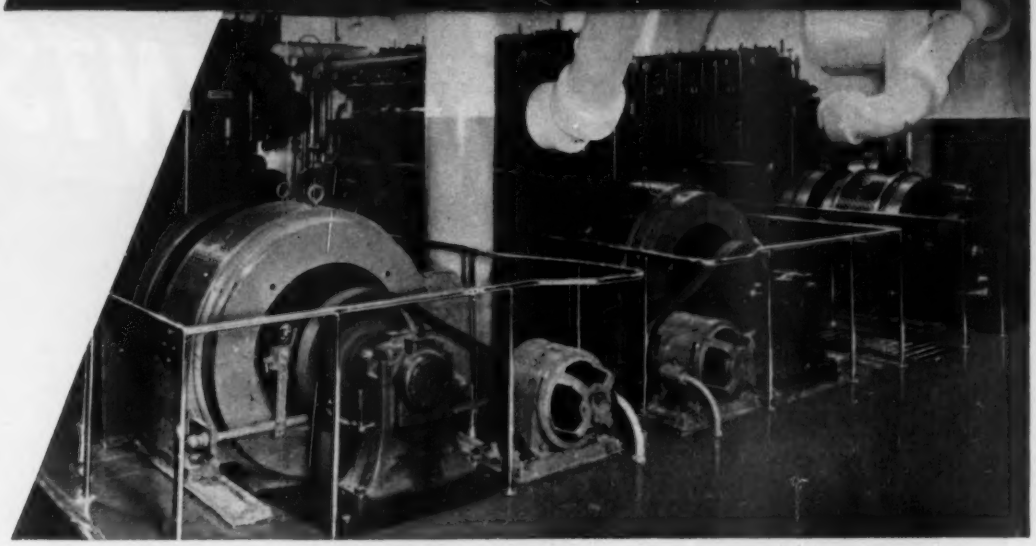
★ ★ ★

SHORT OF SODA ASH for your boiler feedwater treatment? As this is written, a strike has shut down a number of chemical plants, threatening a severe shortage of soda ash, unless some change occurs suddenly. You will remember that a soda ash shortage also occurred in 1947. At that time a number of chemicals were proposed as substitutes for soda ash, to enable power plants to continue treatment of boiler feedwater and thus keep running.

For example, you may be able to do something with caustic soda, if the water conditions are right. Or perhaps alterations in the internal chemical treatment may permit lime softening without soda ash. In other cases, recirculation of boiler water to hot process lime-soda softeners will help. Or Zeolite mineral in a filter bed may serve temporarily, the zeolite effluent being blended with lime-softened water. Barium carbonate has been satisfactorily substituted for soda ash, although the higher cost of doing this may be justified only in an emergency to keep a plant in operation.

The various soda ash substitutes and details of their use were discussed in 1947 in Betz Technical Paper No. 110. If you're already being handicapped by the soda ash shortage, or think you may be, perhaps you ought to look into one or more of those substitutes. In any case, you will, of course, get a competent boiler water treatment chemist to guide you in using them.

YOU CAN MAKE A *DOUBLE* SAVING



Reduce Diesel fuel and maintenance costs by using TEXACO URSA OILS

Clean engines do more to assure Diesel economy than any other one factor. Use *Texaco Ursa Oils* and your maintenance costs, for example, will come down, because *Texaco Ursa Oils* keep harmful carbon and sludge from forming . . . keep rings free, ports open, valves working properly. This means, of course, better compression and combustion . . . with a resulting reduction in the amount of fuel used.

Texaco Ursa Oils are especially made to resist oxidation and to stand up under heat and pressure. They protect bearings from corrosion . . . assure longer life for all moving parts.

Leading Diesel manufacturers approve *Texaco Ursa Oils*, and you can get them in suitable viscosities for every type and size of Diesel. They are easily America's No. 1 Diesel lubricating oils. In fact –

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Get a Texaco Lubrication Engineer to show you how *Texaco Ursa Oils* can make a double saving for you on your Diesel operation. Just call the nearest of the more than 2,000 Texaco Wholesale Distributing Plants in the 48 States, or write:

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to maintain

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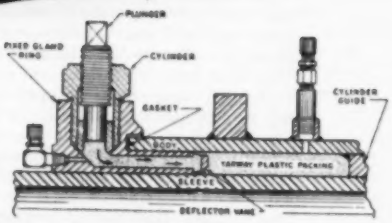

Close-up of cross-section showing detail of Gun-Pakt feature.

YARWAY

Maintenance costs are less because there's less maintenance.

In a nutshell, that's why more and more utilities, institutions and industrial plants distributing steam are turning to Yarway Gun-Pakt Expansion Joints.

Servicing Gun-Pakt Joints never interrupts heating or production. They are serviced under full steam pressure, without shutdowns.

To repack a Gun-Pakt Joint you simply insert a plug of plastic packing, turn a wrench, and the job's done. Special Alemite fittings provide for proper lubrication.

Users report that Gun-Pakt Joints cost little to maintain. One who has kept accurate records says "65 cents per year per joint." Others claim even less.

Available with single or double ends, welding or flanged types, in sizes from 2" to 30", with traverses from 4" to 24", and for pressures to 400 psi.

For the full Gun-Pakt story, as well as information on other Yarway slip-type joints, write for Yarway Bulletin EJ-1912.

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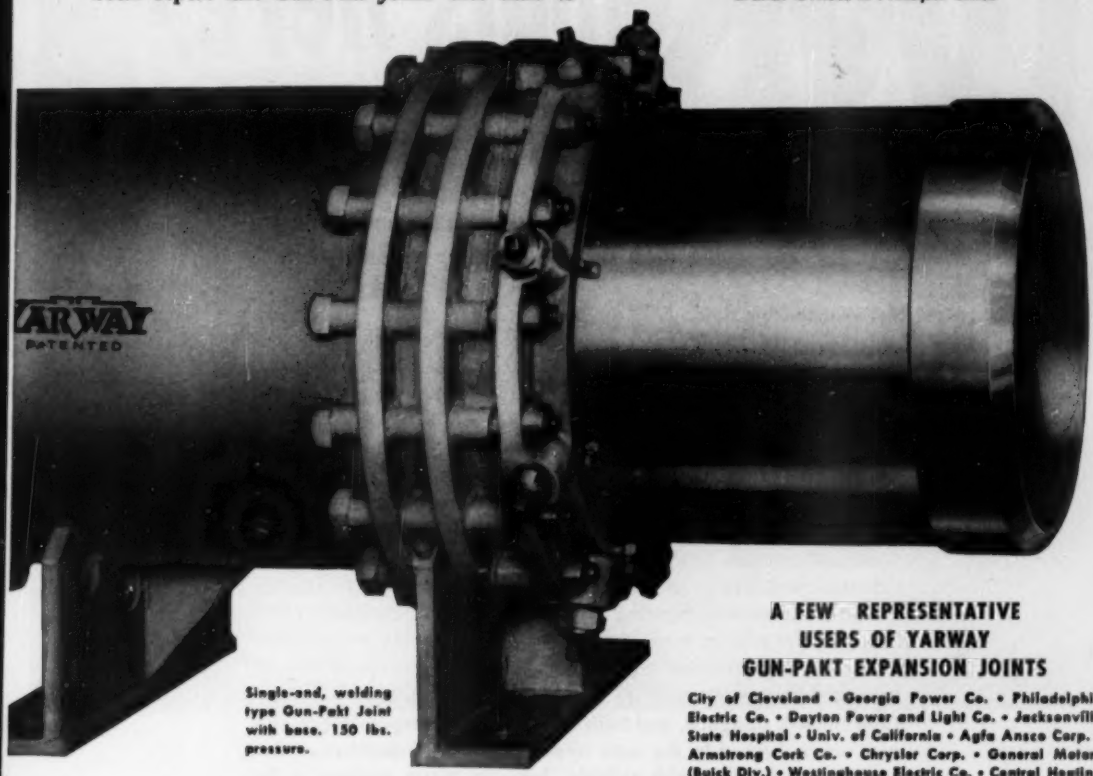

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LOOK what's here!

NOW the popular B&W Integral-Furnace Boiler design available in a cost-saving shop-assembled unit

Now, for the first time . . . all the inherent advantages of "packaged" boilers, *plus* the traditional economies of B&W's Integral-Furnace construction, are combined in a new factory-assembled water-tube unit. It's the B&W Integral-Furnace Boiler, Type FM—delivered fully equipped for immediate operation.

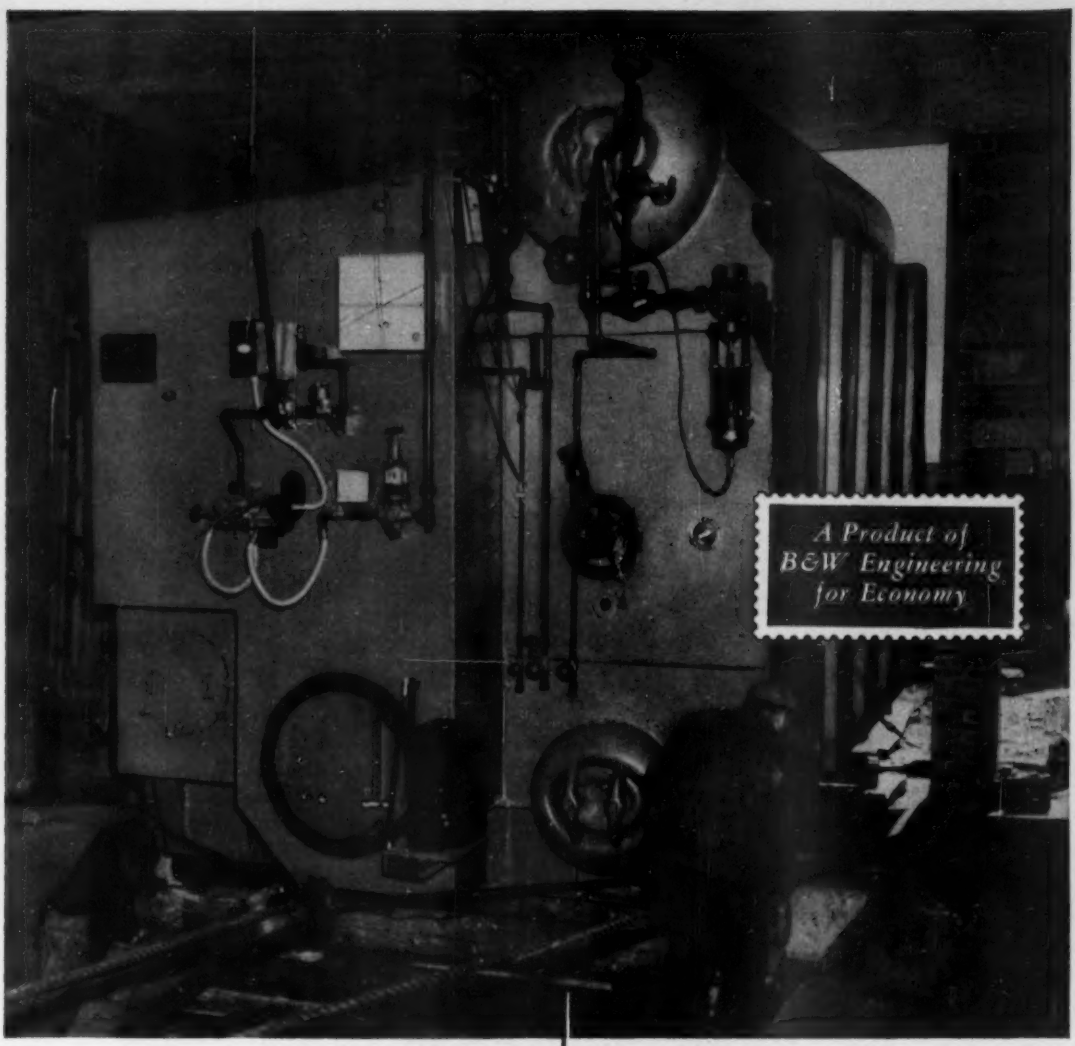
A modern development of the original B&W Integral-Furnace Boiler, this new unit embodies the experience gained through engineering and building over 100 million pounds per hour of installed steam capacity to the same basic design.

Small and medium size plants, institutional and commercial establishments will find in this unit all the answers to low-cost heating and process steam-generating requirements from 3,000 to 35,000 lb. per hr. at pressures to 250 psi. Large plants, too—where space and load characteristics warrant—may profitably consider several packaged boilers as against a "tailor-made" installation.

Coordinated, designed, and built under a single responsibility, this new unit is backed by the same tradition of service-satisfaction that has identified B&W with reliable, low-cost steam generation for more than 80 years.

Send for bulletin G-72, detailing the many advantages of this new B&W creation in low-cost steam generation. The Babcock & Wilcox Company, 85 Liberty Street, New York 6, N. Y.

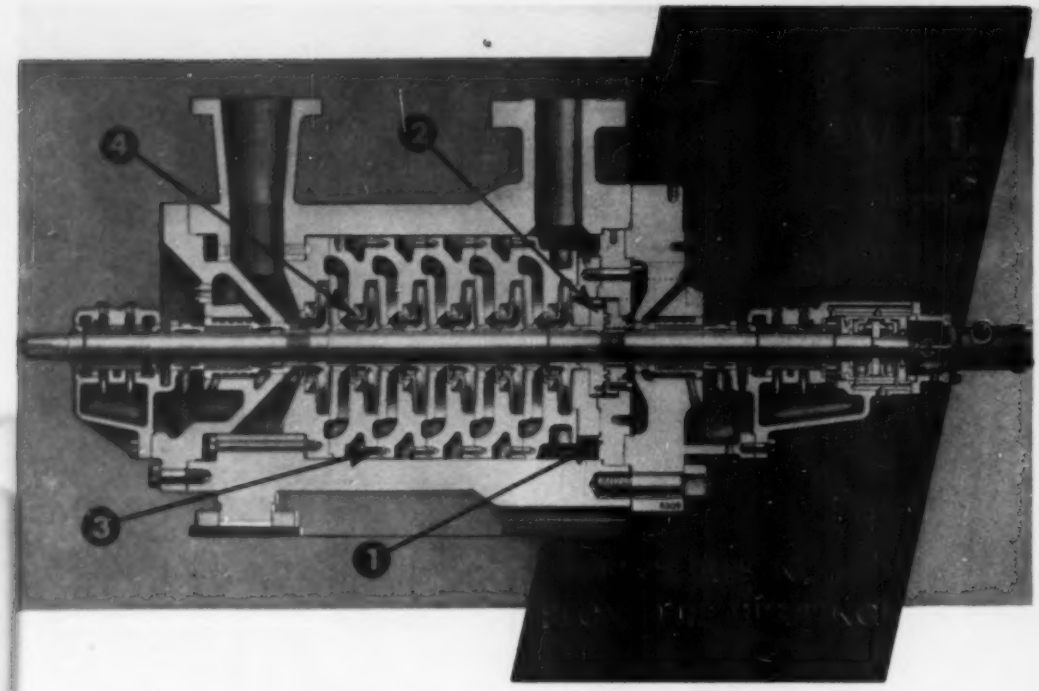
BABCOCK & WILCOX



COST-SAVING FEATURES OF THE NEW B&W INTEGRAL-FURNACE BOILER, TYPE FM

- Saves Erection Time and Cost
- Meets Wide Range of Service
- Handles Quick Load Changes
- Fast Steaming
- Low Maintenance
- Easy Accessibility
- Suitable for Outdoor Service
- Burns Oil and/or Gas
- Saves Fuel
- Saves Space
- Safe, Automatic Operation

490T



The De Laval barrel type boiler feed pump is designed to meet the exacting requirements of modern, fast-steaming, high pressure, central stations. When sudden load changes call for water in a hurry this pump can be thrown on the line quickly without slow pre-heating.

Inspect the above drawing and you'll see how the pump has been designed to minimize the effect of sudden temperature change.

❶ **INNER ASSEMBLY** completely free to expand independently of outer barrel.

❷ **AUTOMATIC HYDRAULIC BALANCING DEVICE** with radial throttle balances all axial thrust completely and automatically — unaffected by temperature change.

❸ **INDIVIDUAL BOLTING OF DIAPHRAGMS** lessens temperature strains.

❹ **LARGE CLEARANCE LABYRINTH WEARING RINGS** have ample tolerance for thermal expansion. Action of these rings does not depend upon maintenance of close clearances.

Send for Catalog 15-7-G

BF-7

DE LAVAL STEAM TURBINE CO., TRENTON 2, N. J.

TURBINES • HELICAL GEARS • CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

COCHRANE

87 YEARS OF SERVICE
COCHRANE CORPORATION
1843 - 1930

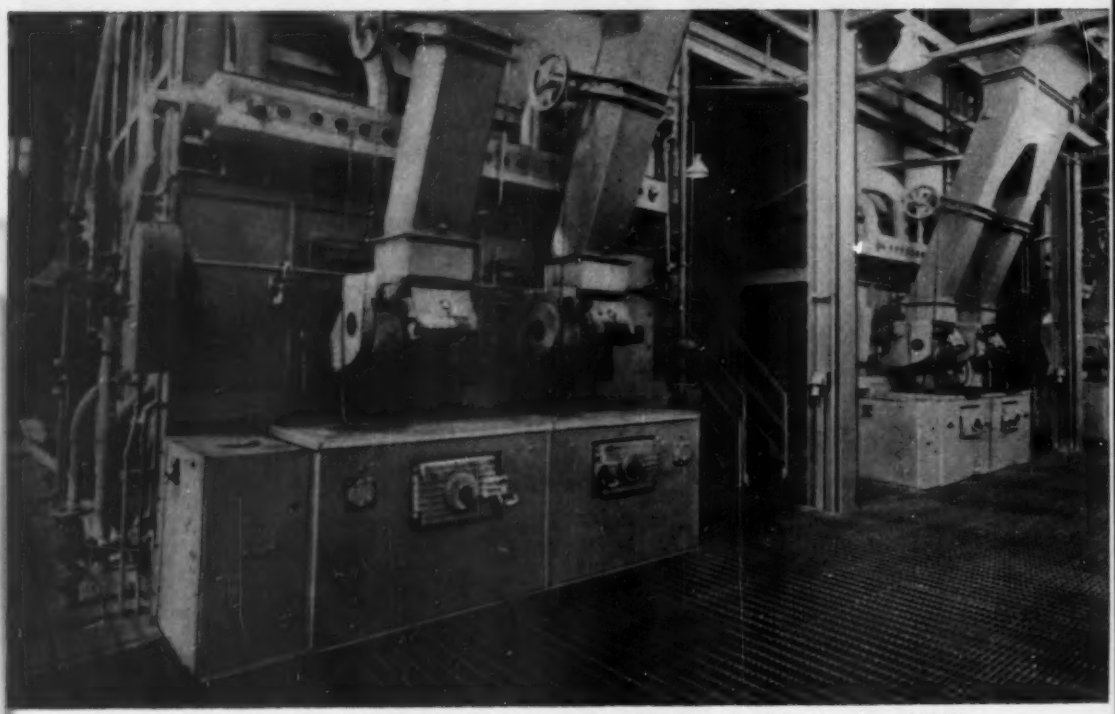
PIONEER AND LEADER IN
METHODS AND APPARATUS FOR
CONDITIONING OF
BOILER FEED, PROCESS AND
INDUSTRIAL WATER SUPPLIES

COCHRANE CORPORATION
PHILADELPHIA 32, PA.

In Canada: Canadian General Electric Co., Ltd., Toronto
In Mexico: Cochrane & Compañía de Mexico, S. A., Mexico
In France: [illegible]

YOU'LL SAVE MONEY WITH A SPREADER

YOU'LL SAVE EVEN MORE WITH A . . .



Three 9' x 15'3" traveling grate Perfect Spread Stokers installed under Erie City Bent Tube boilers deliver a maximum of 55,000 lbs. per hour at a well-known chemical plant in Missouri. Sverdrup & Parcel, Inc., St. Louis, were the Consulting Engineers.

Only Perfect Spread Stoker assures even coal distribution . . . won't clog on wet coal . . . has a cinder return system that works . . . adjustable overfire air

THERE'S NO GUESSWORK about it. You'll save real money – important sums regularly – with a spreader stoker. It enables you to burn a wide range of coals, including the cheaper, high ash coals, with top efficiency. No more paying premiums for coal when you have a spreader stoker. You utilize the coals that are attractively priced in your locality.

IN SPREADER STOKERS – IT'S PERFECT SPREAD – FOR MOST STEAM AT LEAST COST

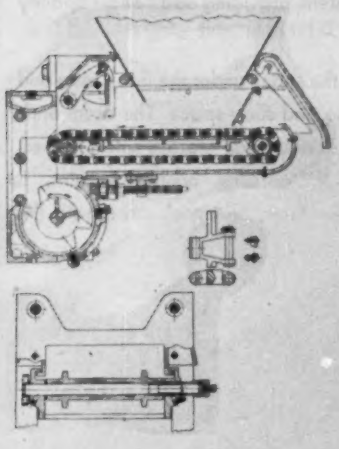
Exclusive features, unique in design, make the Perfect Spread Stoker the most efficient spreader that has ever been built. First and foremost, its feeder assures positive, continuous and accurate coal feed . . . it won't clog even when coal is wet. Next, the spiral overthrow rotor is unmatched for *even* coal distribution. And the engineered cinder reinjection and adjustable overfire air system are final assurance of superior fuel combustion.

Perfect Spread Stokers are made in both continuous discharge, dumping and stationary grate types. Coal feed is adjustable from 50 lbs. to 7,500 lbs. of coal an hour per feeder. Capacities range from 8,000 to 500,000 lbs. of steam per hour. Mail coupon on next page for full information . . . and be sure to call in your Consulting Engineer for recommendations regarding your requirements.

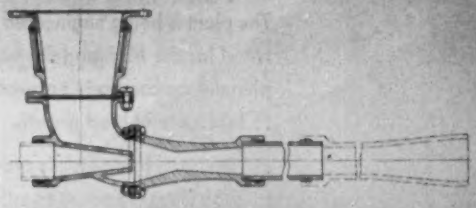
STOKER *BUT* . . . .

PERFECT SPREAD STOKER

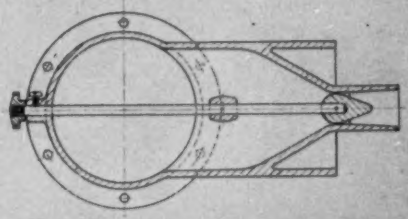
AMERICAN ENGINEERING COMPANY



NON-CLOGGING CONVEYOR FEEDER: Coal enters feeder from hopper, and is conveyed positively, continuously and uniformly forward. Coal is not fed in slugs.



ENGINEERED CINDER REINJECTION SYSTEM: An extremely efficient system; all fittings of alloy iron. Air driven through the venturi section sucks cinders into the air stream for return to the furnace. A *separate* line is provided for each cinder drain point.

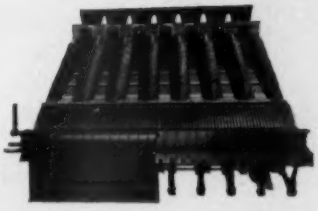


ADJUSTABLE OVERFIRE AIR SYSTEM: Most of the overfire air enters furnace through nozzles in side or rear walls. Each nozzle is a separate venturi-type unit and *individually* adjustable.

WHERE UNDERFEED STOKERS ARE INDICATED YOU CAN'T BEAT THE TAYLOR STOKER

Taylor Underfeed Stokers of adequate grate area deliver over 90% of the ash to the ashpit . . . and most of the remainder is collected in boiler passes without expensive dust recovery equipment.

Shown at right is a 7-Retort, 25 Tuyere Taylor Stoker. It provides low-cost steam for plants of moderate size. The principles of combustion are identical with those of the high capacity Taylor Stokers that are the standard for central stations and large industrial plants.



AE

AMERICAN ENGINEERING COMPANY

PHILADELPHIA 25, PENNA.

Other AE Products are Marine Deck Auxiliaries, Hele-Shaw and Hydramite Fluid Power, Lo-Hed Hoists, Car Shakers, Car Pullers.

American Engineering Company
2408 Aramingo Ave., Philadelphia 25, Pa.

Gentlemen: We are interested in "most steam at least cost." Send me full information about ____ Perfect Spread Stokers; ____ Taylor Stokers.

Name _____ Title _____

Company _____

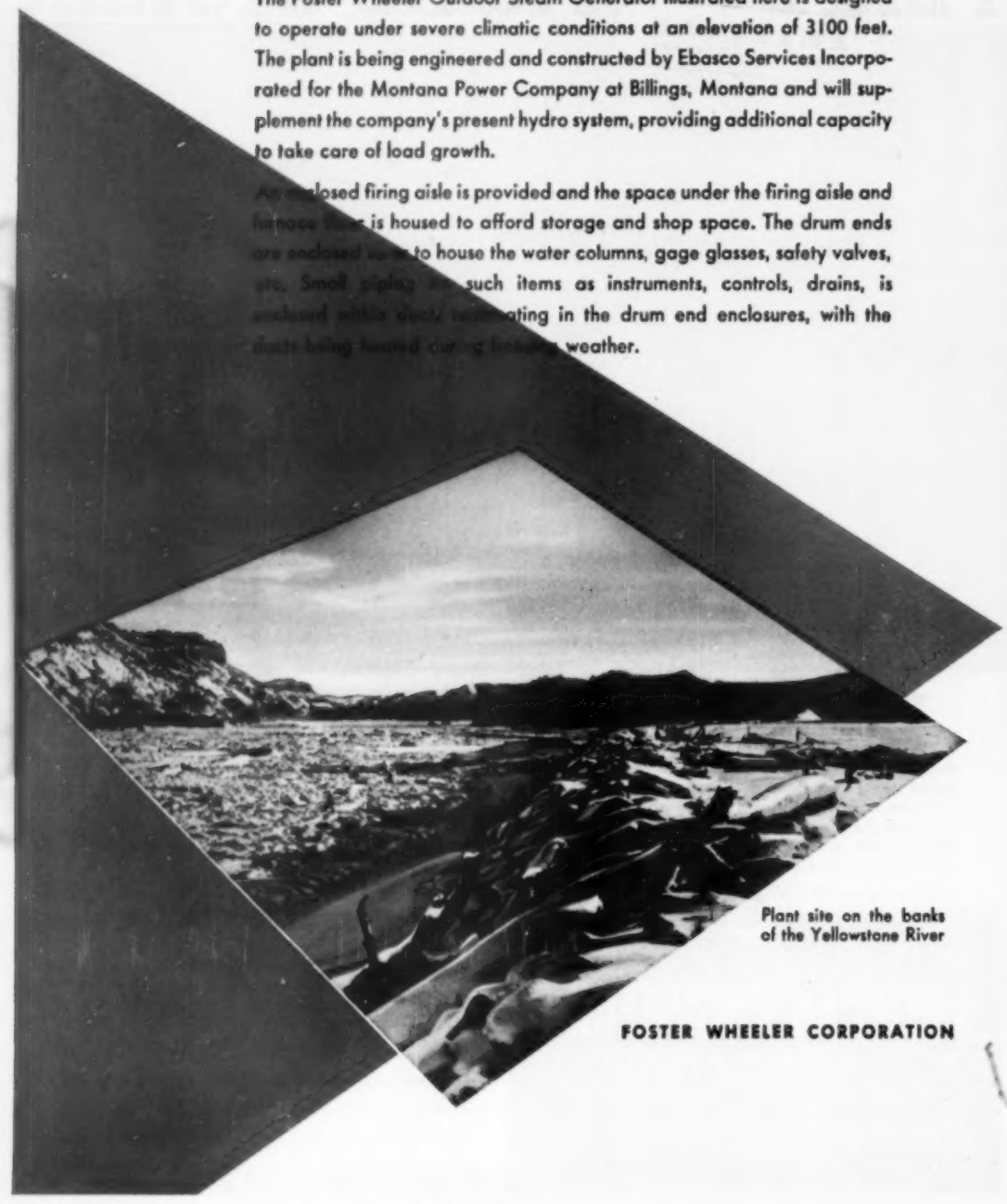
Address _____

City _____ Zone ____ State _____

"operation" SUB-ZERO

The Foster Wheeler Outdoor Steam Generator illustrated here is designed to operate under severe climatic conditions at an elevation of 3100 feet. The plant is being engineered and constructed by Ebasco Services Incorporated for the Montana Power Company at Billings, Montana and will supplement the company's present hydro system, providing additional capacity to take care of load growth.

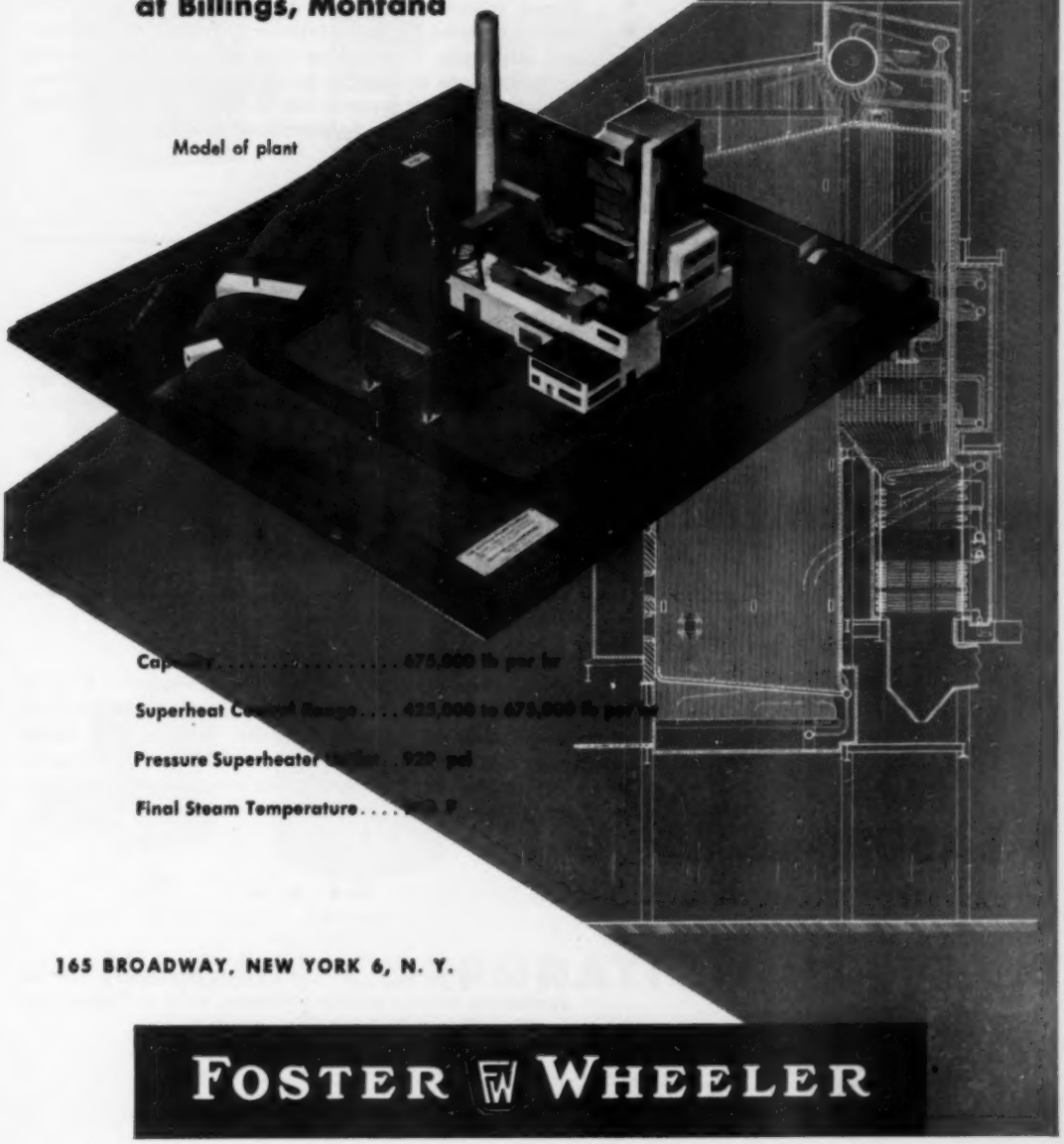
An enclosed firing aisle is provided and the space under the firing aisle and furnace floor is housed to afford storage and shop space. The drum ends are enclosed as well to house the water columns, gage glasses, safety valves, etc. Small piping for such items as instruments, controls, drains, is enclosed within ducts terminating in the drum end enclosures, with the ducts being heated during inclement weather.



Plant site on the banks of the Yellowstone River

FOSTER WHEELER CORPORATION

FOSTER WHEELER
Outdoor Unit for the
MONTANA POWER COMPANY
at Billings, Montana



Model of plant

Cap[illegible] . . . . . 675,000 lb per hr

Superheat C[illegible] Range . . . . 425,000 to 675,000 lb per hr

Pressure Superheater [illegible] . . 920 psi

Final Steam Temperature . . . . [illegible] F

165 BROADWAY, NEW YORK 6, N. Y.

FOSTER WHEELER

Equipment by

for CONTROL SYSTEMS

Hagan pioneered in the field of automatic combustion control systems for both stationary and marine boilers—and still leads. Engineering of these and other control systems is one of Hagan's major activities, but the components of these systems are suitable for many other applications, and may be purchased separately.

for FLOW MEASUREMENT

The Hagan Ring Balance Flow Meter is a rugged and accurate instrument, adapted for a wide range of static and differential pressures. Calibration is the same for dry or wet service; range changing is exceptionally easy. Suitable for water, steam, air, gas, oil, and other fluids. *No stuffing boxes.* Calibration by dead weight method checks or takes the place of water column methods. Photos show a few typical models of this meter.

for FORCE MEASUREMENT and other purposes

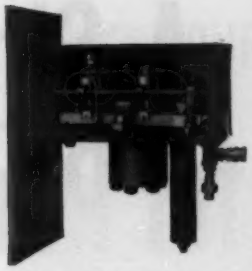
As designers of control systems, Hagan engineers have on many occasions encountered problems which required the development of special equipment. Some of this equipment has proved to have a wider field than the original application, and has been made commercially available. Several such units are shown here.

• • •

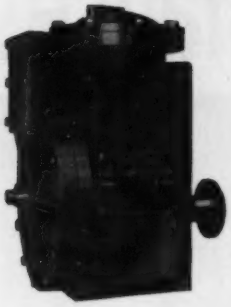
For full information on any of this equipment and its application to your specific problems, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN

Diaphragm Regulator

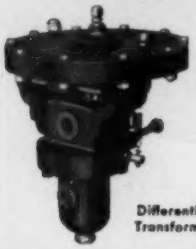


Type "F" Master Sender



Variable Ratio Regulator

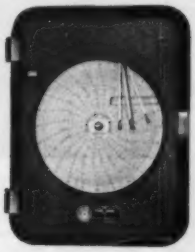
Receiving Regulator



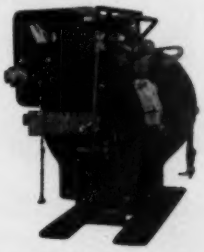
Differential Transformer

Type "F" Totalizer

Ring Balance Flow Meter (Indicating, Integrating & Recording)

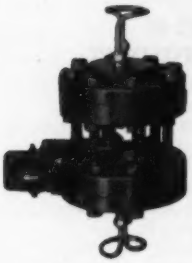


Ring Balance Flow Meter (Integrating & Recording)



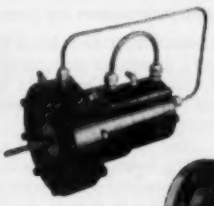
Dual Meter with Integrator (Case Removed)

Single Ring Meter without Integrator (Rear View)



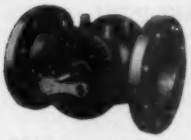
Hagan ThrusTorq

Steam Separator



MicroServo

MicroTrans



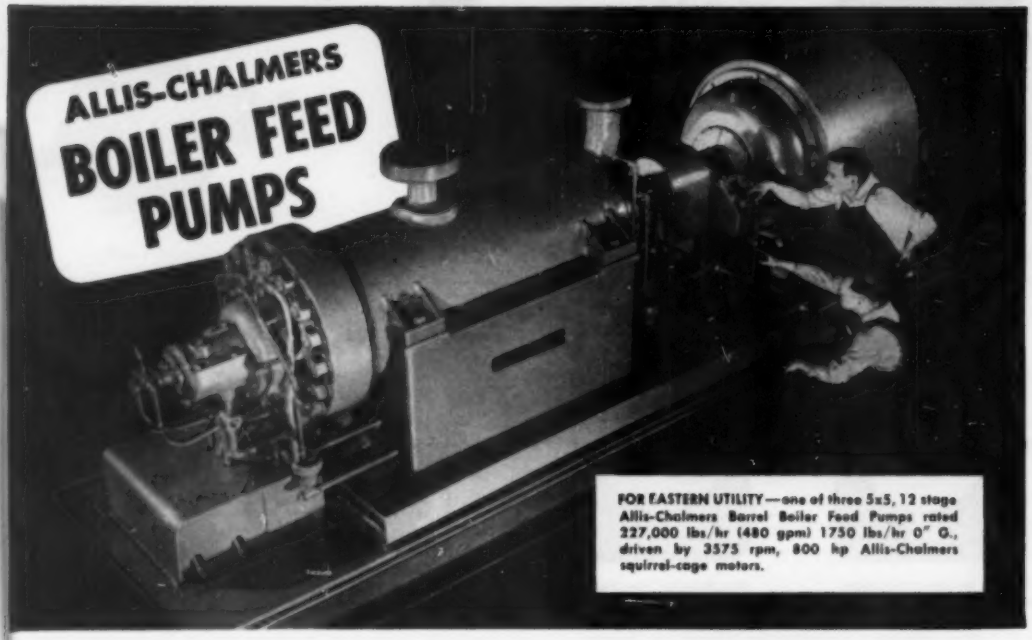
V Port Butterfly Valve

Thermostat

HAGAN CORPORATION

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

A Single Responsibility for Pumping Performance!



FOR EASTERN UTILITY—one of three 5x5, 12 stage Allis-Chalmers Barrel Boiler Feed Pumps rated 227,000 lbs/hr (480 gpm) 1750 lbs/hr 0° C., driven by 3575 rpm, 800 hp Allis-Chalmers squirrel-cage motors.

BEAT THIS KIND OF COMBINATION — *at any price:* An excellent quality boiler feed *pump*, high reliability *motor*, and complete *control*—all Allis-Chalmers built and backed!

You save time and money in negotiation, installation and operation.

ASK THE POWER PLANT USER!

Regardless of which of the 3 Allis-Chalmers boiler feed pumps described at right you finally settle on, here's the kind of *maintenance* operational record you can expect and get when you invest in A-C:

EASTERN UTILITY, 735 gpm pumps, "after 45,000 hours no measurable wear on shaft sleeves, rings or internal parts."

MIDWEST UTILITY, 6 x 4, 5-stage pumps, "After 82,000 hours not .001 inch wear on any internal part."

OHIO UTILITY re-ordered three 1800 p.s.i. pumps on strength of this performance — "Only .002 inch wear on rings after 8 years operation on pumps."

And on the motor end, a midwest Utility reports, "in over 20 years of uninterrupted service with three, 800 hp, two-pole motors driving boiler feed pumps we've had to order replacement parts just twice at a total cost averaging less than $12 a year!"

CHOOSE FROM 3 TYPES PUMPS:

☛ Barrel-type, for larger steam stations operating against the higher pressures, 1200 to 2500 lbs; 300 to 2000 gpm.

☛ "Doubleton," for pressures between 1200 and 1800 p.s.i.

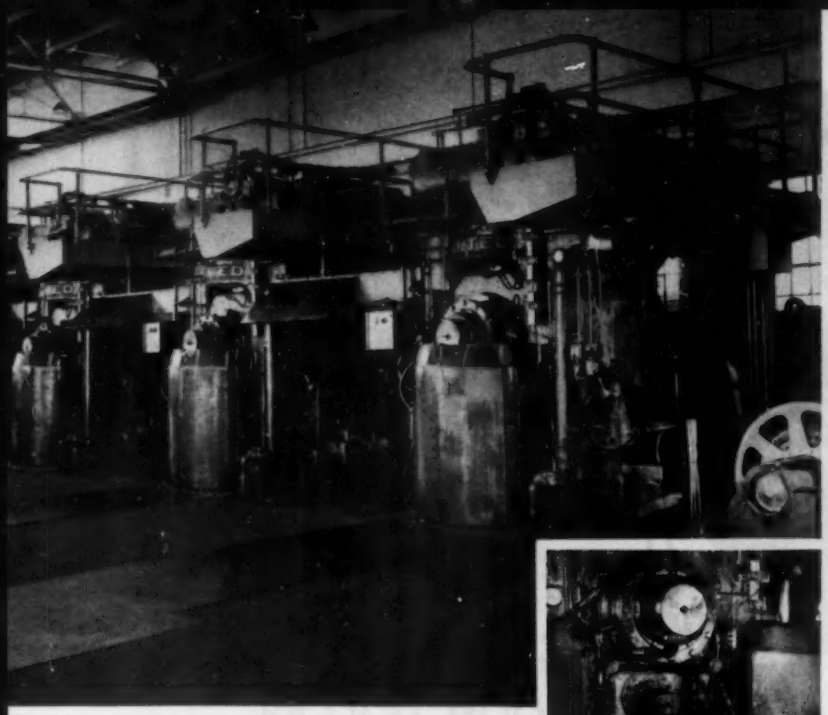
☛ Standard Type "M," for pressures usually under 1200 p.s.i.

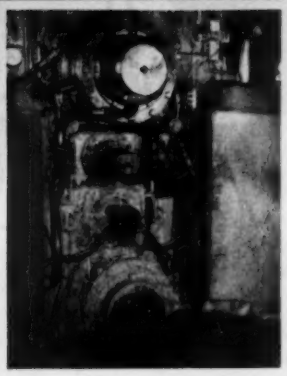
BENEFITS OF "PACKAGE" INVESTMENT

Yes, for *quality* performance in *your* power plant, get hold of an Allis-Chalmers pump application engineer today. He's an *expert* at figuring requirements at the economy point. And he's ready to show you *where* and *how* a complete Allis-Chalmers "Power Plant Pumping Package"... pumps, motors, control, will keep you ahead in time, performance, and freedom from worry. A-3040

ALLIS-CHALMERS, 953A SO. 70 ST. MILWAUKEE, WIS.

ALLIS-CHALMERS





Putting the "squeeze" on maintenance costs

IN this modern 5-stand tandem cold-rolling mill at a midwest steel mill, giant backup rolls squeeze strip steel to thousandths of an inch thickness. Taking the brunt of this punishing work are the end bearings on the rolls. Protection and proper operation of these bearings call for a lubricant that can really take it.

Recommended by a Standard Oil lubrication specialist, a STANOIL Industrial Oil has been used on these bearings for 1½ years of hard, continuous operation. Clean, effective lubrication, together with excellent maintenance practices by mill operators, has held bearing-upkeep costs to a minimum. The oil-circulating system, which includes two 6,000-gallon oil tanks, has remained entirely clean. STANOIL has shown practically no deterioration in use.

You can rely on this unique multi-purpose oil to give you the same, clean, dependable service in hydraulic units, speed reducers, and circulating systems. You can rely, too, on the expert, on-the-spot service of a Standard Oil lubrication specialist. How you can obtain his help, quickly and easily, is explained at the right.

Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Ill.

STANOIL
TRADE MARK
Industrial Oil

What's YOUR problem?

Warren Erickson, Lubrication Engineer at Standard Oil's Chicago office, helped this midwest steel mill (see left) make important savings through the use of STANOIL Industrial Oil on a cold-rolling operation. He was close at hand, gave mill operators engineering service when they needed it.

There's a corps of Standard Oil Engineers and lubrication specialists throughout the Midwest. You'll find one located near your plant. You can reach him simply by phoning your local Standard Oil Company (Indiana) office. His experience and special training will help you get maximum benefits from STANOIL and other outstanding products such as:

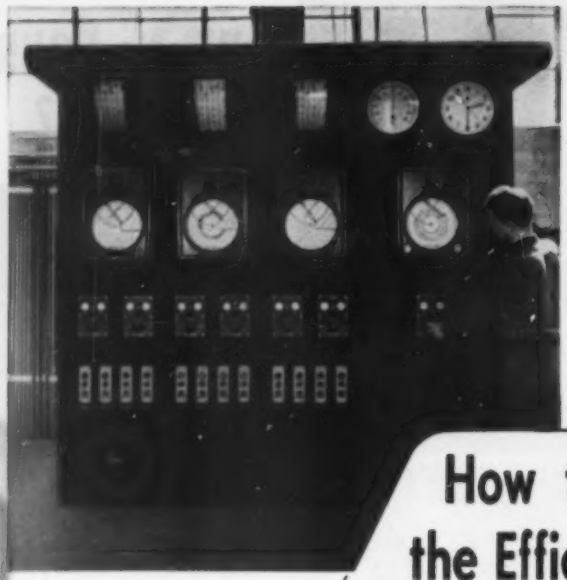
STANICUT Cutting Oils. These special-duty cutting oils meet today's most exacting requirements and highest production schedules. Grades vary in viscosity and compounding. Each contains the correct proportion of extreme-pressure and friction-reducing ingredients.

STANICOOL HD Soluble Oils. Because of additional compounding, these heavy-duty soluble oils possess the cooling ablity of an emulsion and also give better tool life and finer finishes than do conventional soluble oils.

STANOSTAMP Compounds. These widely accepted products have demonstrated their ability to handle heavy stamping or drawing operations of low-carbon or alloy steels. Each of the three grades is a paste compound to which water can be added to provide the most economical applications. STANOSTAMPS offer maximum protection for dies and work, can be readily removed in conventional washing equipment.

STANDARD OIL COMPANY (INDIANA)

STANDARD



These Bailey Boiler Controls at the Chicago Pneumatic Tool Company's new plant in Utica, N. Y. insure efficient operation of three 25,000 lb per hour, 100 psi, spreader stoker-fired boilers

How to INCREASE the Efficiency of YOUR BOILER-ROOM DOLLAR

Before you get steam you've got to spend dollars—so dollars are a form of energy.

And if your boiler-room dollars are invested in equipment that isn't working efficiently, economically, your "investment" is poor.

That's where co-ordinated controls by Bailey can help. Here's why they'll increase your "boiler-room investment efficiency":

1. **Complete Range of Equipment—fully co-ordinated.** You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. **Engineering Service—backed by experience.** No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement and automatic control.

3. **Direct Sales-Service — conveniently located near you.** Bailey Meter Company's sales-service engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

•

For better "boiler-room investment" efficiency —for more power per fuel dollar, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More power to you!"

A-111-0

BAILEY METERS

BAILEY METER COMPANY

1040 IVANHOE ROAD
CLEVELAND 10, OHIO

Controls for Steam Plants
COMBUSTION · FEED WATER
TEMPERATURE · PRESSURE
LIQUID LEVEL · FEED PUMPS

For easier, better welding . . .

GRINNELL WELDING FITTINGS

A qualified welder can make welds quickly and easily with Grinnell Welding Fittings. These fittings are made by a hydraulic forging process that assures uniform wall thickness at all points and true circularity throughout. Of seamless, one-piece construction, they can be cut at any angle to match up with standard weight, and extra strong and heavier wall pipe in I.D. or O.D. sizes. Pressure-temperature ratings are equal to or greater than those of seamless steel pipe. Grinnell Welding Fittings are process stress-relieved.

Permanent Identification

Each Welding Fitting bears a metal plate giving size, wall thickness, material and name for easy, positive identification.

Full Length Outlets

Full length outlets permit fast lining up and ample room for rod manipulation; keep high welding heat away from vital crotch zones.

Uniform Wall Thickness

Uniform wall thickness at all points permits perfect lineup with pipe, O.D. and I.D. No thinning of long outer wall . . . no thickening of short inner wall. Complies with code requirements.

True Circular Section

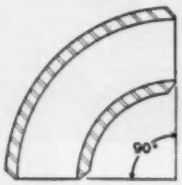
True circular section at all points makes fitting easy to align and weld . . . no distortion or flattening to affect flow adversely.

Plain Circumferential Butt Welds

Grinnell Welding Fittings confine all welds to plain circumferential butt welds — with their inherent strength and simplicity.

Accurate Bevels

Accurate bevels aid aligning and welding. Standard straight bevel for thickness (T) 3/16 to 3/4 inch inclusive. Standard U-bevel for thickness (T) greater than 3/4 inch.



True Included Angles

True included angles permit fabrication and erection of complicated piping systems to exact measurements.

Send for copy of this new catalog showing the complete line of Grinnell Welding Fittings and Forged Steel Flanges.

100th ANNIVERSARY — WHEREVER PIPING IS USED

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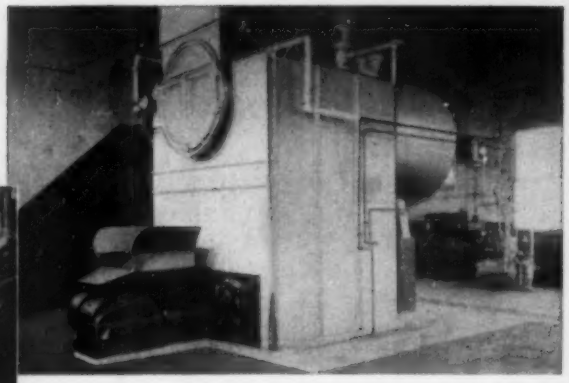
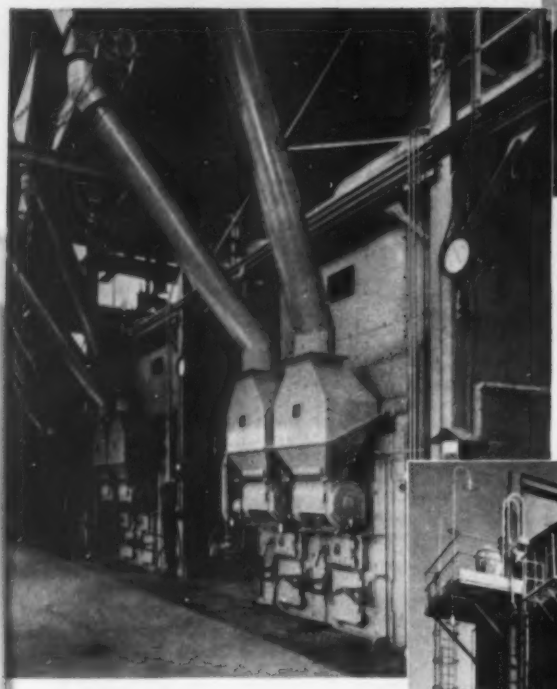
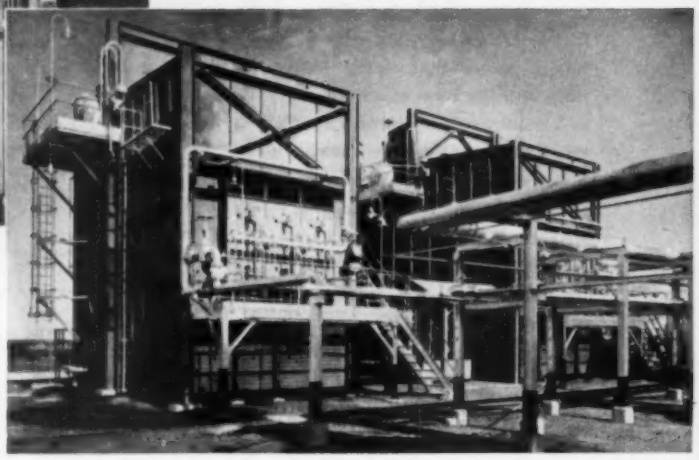




Planning



Installation for medium and smaller plants . . . pressure to 475 psi . . . capacity to 60,000 lbs. of steam per hr . . . suitable for any type of fuel.

Installation for larger plants . . . pressure to 1000 psi . . . temperature to 900 F . . . capacity to 350,000 lbs. per hr . . . any fuel or type of firing . . . indoor or outdoor type construction.

COMBUSTION ENGINEERING

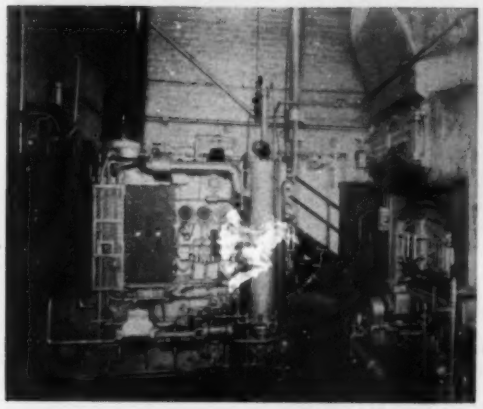
A MERGER OF COMBUSTION ENGINEERING COMPANY, INC. AND THE SUPERHEATER COMPANY

Installation for small plants . . . pressure up to 150 psi . . . capacity to 12,000 lbs. of steam per hr . . . adaptable to any fuel.

? to buy BOILERS

. . . this year

. . . next year



Installation for special conditions including very limited space . . . quick steaming (full capacity in 3 min.) . . . fully automatic operation . . . capacity to 6000 lbs. of steam per hr . . . pressure to 300 psi. Ideal for intermittent load.

Sometime this year, or perhaps next, your company may decide to buy new boilers . . . to replace obsolete units . . . to meet increasing steam demands . . . or for a new plant. Whatever the time or circumstances, here's something it will pay you to remember. With fuel and operating costs firmly established at new high levels, today more than ever before, the first cost of a new boiler is decidedly secondary to the annual operating cost. In fact, the annual cost of fuel alone for the average boiler installation nowadays usually equals or exceeds the purchase price. And the normal life of a boiler should be 20 to 30 years, or longer.

Obviously, then, the operating economies accruing from better design, construction or application, will quickly offset the difference between the cheapest boiler you can buy and the best the market affords. Here is one case where the old adage "the best is the cheapest" really applies.

In addition to having installed thousands of industrial boilers . . . in every size category from less than 100 horsepower up . . . Combustion has designed and built many of the country's largest utility power station boilers. And it is in this field – the manufacturing of power on a large scale – that boiler design and construction are evaluated most critically and exhaustively.

The fact that C-E Boilers have been selected to meet the exacting performance standards of so many of the nation's largest utility power stations is evidence of the quality of design and construction you can expect to find in any boiler, large or small, that bears the Combustion nameplate.

Our recommendations as to the most suitable type of boiler and firing equipment for the *specific requirements* of your next installation are available to you and your consultants without obligation.

B-383A

— SUPERHEATER, INC.

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● THE MUNICIPAL ELECTRIC PLANT

of MUSCATINE, IOWA

Knows the value of

Automatic Control

Republic automatic boiler control and instrument panels at Muscatine Municipal Electric Plant

● In 1941 the Municipal Electric Plant at Muscatine, Iowa, installed a modern 100,000 lb. per hr. steam generator. In 1948 a second boiler rated at 160,000 lb. per hr., 650 psi. was added.

In any steam electric generating plant, electric power rates and steam costs go hand-in-hand. Low steam cost however, is not the result of efficient boiler design alone. To realize all the operating advantages of these modern boilers, each was equipped with a Republic automatic combustion and feed water control system at the time of installation.

The installation of Republic automatic controls on your boiler or (boilers) will enable you to:—

SAVE FUEL by automatically maintaining highest combustion efficiency.

INCREASE STEAM OUTPUT by operating the boilers at test efficiency 24 hours a day, 7 days a week.

CONSERVE MANPOWER by automatically performing the many routine repetitive adjustments.

REDUCE OUTAGES by maintaining uniform operating conditions.

Find out about Republic control systems. One of our engineers will be glad to consult with you at any time. Write us today.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

14 AUTO-LITE PLANTS
DETROIT STOKER EQUIPPED

TOLEDO (Ketcham Ave. Plant)
3 DETROIT STOKERS

BAY CITY, MICH. (Bay Mfg. Div.)
3 DETROIT STOKERS

SPRINGFIELD, O. (Springfield Div.)
1 DETROIT STOKER

WOODSTOCK, ILL. (Die Casting Div.)
2 DETROIT STOKERS

FOSTORIA, O. (Spark Plug Div.)
3 DETROIT STOKERS

PORT HURON, MICH. (Wire & Cable Div.) 4 DETROIT STOKERS

SARNIA, ONT. (Electric Auto-Lite Ltd.) 4 DETROIT STOKERS

SHARONVILLE, O. (Bumper Div.)
3 DETROIT STOKERS

CINCINNATI (Lamp Div.)—2 DETROIT STOKERS

FOSTORIA, O. (Foundry Div.)
2 DETROIT STOKERS

LA CROSSE, WIS. (Instrument & Gauge Div.) 3 DETROIT STOKERS

TOLEDO (Stickney Ave. Plant)
2 DETROIT STOKERS

TOLEDO (Champlain Street Plant)—3 DETROIT STOKERS

VINCENNES, IND. (Auto-Lite Battery Corp.)—1 DETROIT STOKER

DETROIT SINCE 1911 STOKERS

36 DETROIT STOKERS SINCE 1929 . . . FOR

THE ELECTRIC AUTO-LITE COMPANY

Overwhelming Evidence of Satisfactory Performance

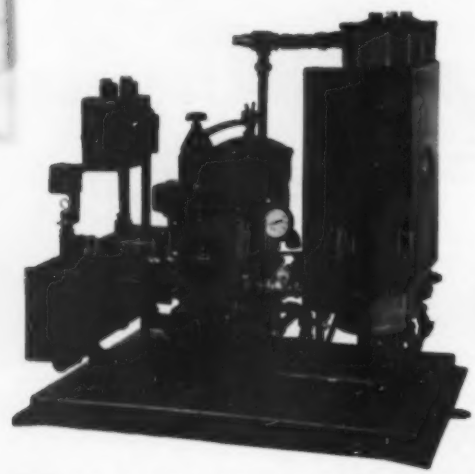
DETROIT STOKER COMPANY

GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN

3

The De Laval "Puri-Filter" — centrifuge plus filter — has now been on the scene approximately three years. The numerous installations made during that time now give ample proof that the basic idea behind the "Puri-Filter" is correct. Centrifugal force and micronic filtration can do a more thorough job of cleaning diesel oil than any other device in existence, and better, in fact, than either centrifugal force or filters by themselves. It is economical, too — the centrifuge relieves the load on the filters and lets them remain in service longer.

The De Laval "Puri-Filter" removes the materials that cause ring sticking, sludging and coking. Dirt, water and colloidal carbon are all promptly separated out of the oil, which is left clean and clear in color, and ready for indefinite re-use.



THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

DE LAVAL
Oil Purifiers
FOR DIESEL LUBRICATING OIL

We Studied SAFETY VALVE LEAKAGE

— Here's what we found out about SEATING...

We found — what most power plant men already know...that in order to be tight, a safety valve must have matched, wear resistant, corrosion resistant seating surfaces, and that the disc must seat square.

We found — what power plant men have long suspected...that uneven expansion, causing dragging of one seating surface over the other, can destroy the seat so completely that the safety valve has to be overhauled or replaced, even though it has never been popped.

We found ...that when nozzle and disc are made of alloys with the same coefficient of expansion, and with sections designed so that their rate of heat absorption is the same, destructive drag is eliminated. This is one of the basic features of the Gentzel Design, and is the reason Foster 38-SV Safety Valves can be guaranteed to stay tight.

To you ...this means elimination of costly boiler outage due to safety valve leakage. Other guaranteed and proven advantages are...consistently accurate popping ...minimum blow-down, which can be held to as little as 1% ...highest relief capacity for a given nominal valve size...and extremely low maintenance.

One Executive of a large Eastern Utility put it this way, "Leakage is a serious item. Every time we have to shut down for leaky safety valves, we tie up several million dollars worth of equipment. It costs us thousands of dollars a day."... The Superintendent of a mid-west generating station said, "My Foster 38-SV's are the only safety valves I have that don't leak."

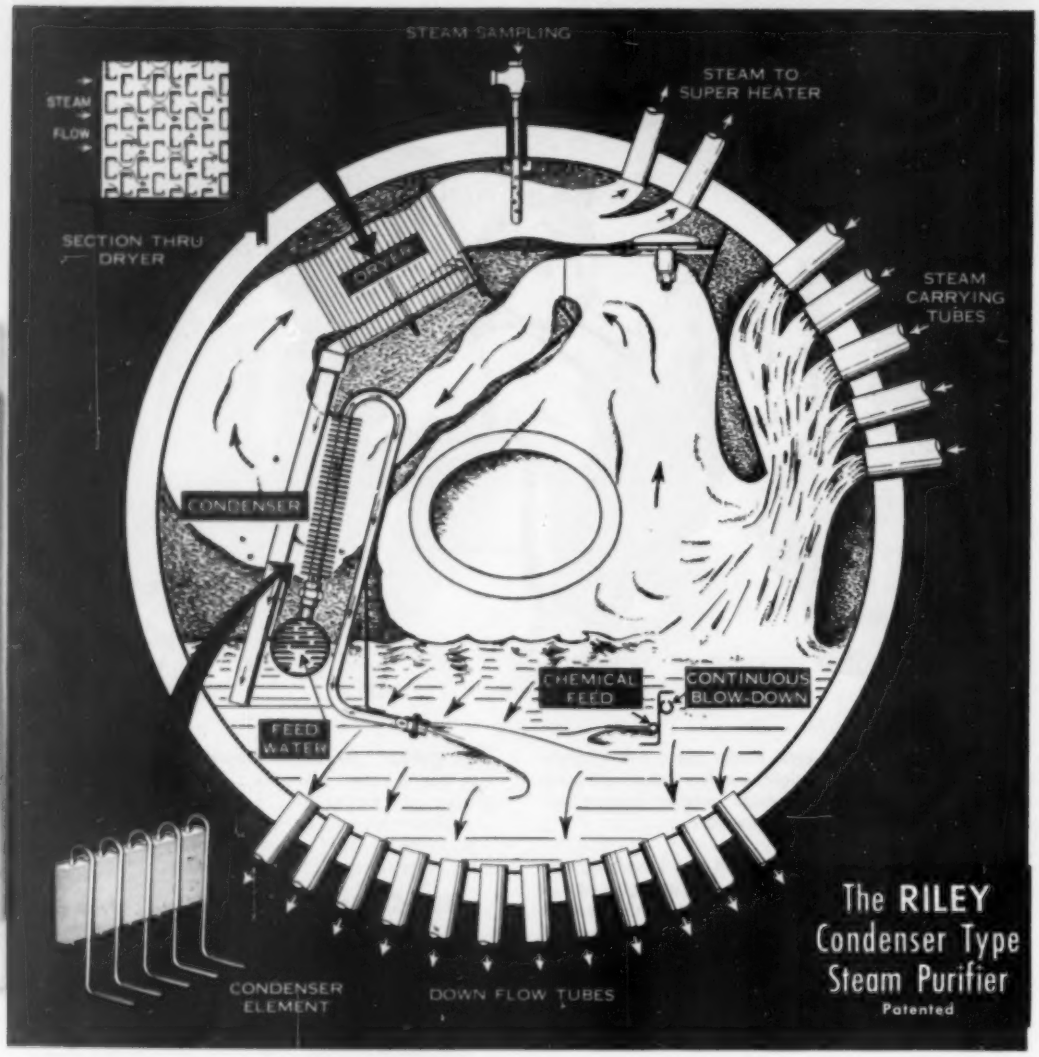
Foster 38-SV Gentzel Design Safety Valves are made for pressures as low as 35 pounds as well as for pressures in excess of 2500 pounds. For details on the design and construction features that enable this valve to outperform ANY other safety valve... and for a list of installations near you, get in touch with your Foster Representative or with us direct.

FOSTER ENGINEERING Company

PRESSURE REGULATORS ... RELIEF AND BACK PRESSURE VALVES ... CUSHION CHECK VALVES ... ALTITUDE VALVES ... FAN ENGINE REGULATORS ... PUMP GOVERNORS ... TEMPERATURE REGULATORS ... FLOAT AND LEVER BALANCED VALVES ... NON-RETURN VALVES ... VACUUM REGULATORS OR BREAKERS ... STRAINERS ... SIRENS SAFETY VALVES FLOW TUBES

835 LEHIGH AVENUE • UNION, N. J.

Exceptional steam purity with the



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Denver · Salt Lake City · Los Angeles · Portland · Seattle

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • FLUE GAS SCRUBBERS

New Riley Condenser Type Purifier

Silica carryover reduced to minimum

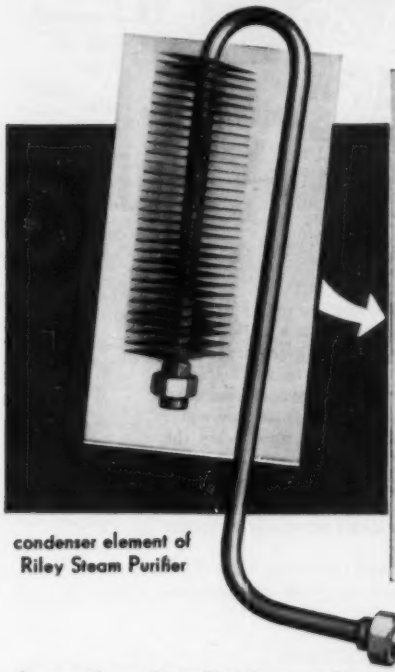
Exceptional steam purity with a minimum of silica carryover is being obtained from Riley Steam Generating Units equipped with the new Riley Condenser Type Steam Purifier. Steam purity well below 0.5 ppm is consistently obtained at installation after installation even with high percentage of make-up.

With Riley units, steam is liberated above the working water level promoting ready separation of steam and water. The condenser type purifier not only removes most of the total entrained solids from the steam but also sufficient quantities of the volatilized silica to greatly minimize difficulties from silica scale on the blades of intermediate turbine stages—an important feature with high pressure installations.

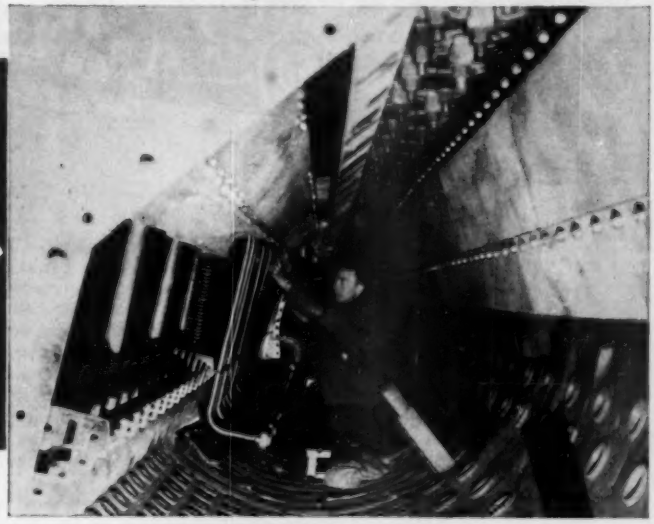
The Riley condenser type steam purifier is ruggedly constructed and securely mounted in the drum to maintain proper alignment. It occupies a minimum of internal drum space, providing ample space for inspection and cleaning of tubes connected to the drum with a minimum of dismantling. Weight of the individual purifier elements permits easy installation and removal.

Riley engineers will gladly give you detailed information about this important Riley development. Phone or drop a line to the nearest Riley office.

You Can Rely on Riley



condenser element of Riley Steam Purifier



View of Internals of Riley Steam Drum
Note ample space for inspection

A survey of your Power Plant by a consulting engineer will possibly show ways of making surprisingly large savings [illegible] costs

COMPLETE STEAM GENERATING UNITS

. . . it will pay you to visit modern Riley Installations before purchasing Boiler or Fuel Burning Equipment

ECONOMIZERS WATER-COOLED FURNACES • STEEL-CLA[illegible] • AIR HEATERS

Got a Locomotive Handy ...In Case?

EVERY so often a steam locomotive makes news by going to the rescue of a plant where the steam system gave out at a critical time.

This is one answer to continued steam production pending repairs . . . and undoubtedly an expensive one. Simplest—and most economical—is to use the Nalco System and eliminate the chances of boiler down time due to faulty water treatment.

Nalco chemicals and services aim at *water treatment results* from raw water intake to condensate hot well . . . And the thousands of plants now using the Nalco System testify to the accuracy of this aim during the past twenty-six years. Whether your plant is large or small; your water problems scale, corrosion, carry-over—or just plain high cost—unless you have a locomotive handy for emergencies, better check with Nalco today. No obligation . . . and an excellent chance for permanent water treatment security.

P. S. More steam locomotives use Nalco-treated water than any other kind . . . Perhaps the reason why locomotives *can* be of help in plant emergencies!

NATIONAL ALUMINATE CORPORATION

6224 West 66th Place • Chicago 38, Illinois

Canadian inquiries should be addressed to
Alchem Limited, Burlington, Ontario, Canada

THE *Nalco* SYSTEM . . . Serving Industry through Practical Applied Science

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

ELECTRICAL

101 Rural Service Transformers—Bulletin GEA-GIBERSON, 6 pp. on rural service distribution transformers describes and illustrates three basic types: the RU with double gap and internal protective link, the RU with arrester-fused limited combination, and the ACP with built-in secondary breaker. The bulletin also describes the conventional Type RU distribution transformer designed for application to lines of 13,200 Y v and below. Allis-Chalmers Mfg. Co.

102 Circuit Breakers—Bulletin 2610, 12 pp. describes fully magnetic, non-thermal, non-enclosed, general purpose circuit breakers. Illustrations, charts diagrams, graphs and cutaway drawings showing company's line of one-, two- and three-pole breakers for general industrial use. Special treatment is given the subjects of true inverse delay, high speed latch and magnetic blowout. Time overload curves and coil resistance curves are also included. Besides terminal construction, several types of coil connections are described—series overload, calibrating tap, shunt trip and relay trip. Heinemann Electric Co.

103 Custom Built Equipment—The advantages of using electrical equipment built to job requirements, and the work involved in its production, are touched upon in Bulletin 2-200, 10 pp. Illustrates and describes a-c and d-c motors and generators, motor-generators, frequency changers, battery chargers and electrolytic power supplies. The Electric Products Co.

104 Transformer Test Set — Four-pp Bulletin 34 tells how and where to use a current transformer testing set, described as a simple and inexpensive instrument—a multi-range ammeter—for quick checking of transformer installations for possible trouble sources without interrupting service. Explains and illustrates operation of the instrument, discusses safety precautions, insulation, damping, current ranges. The Eastern Specialty Co.

PIPING, VALVES AND ACCESSORIES

105 Copper Tubes—Where and How to Use Them—Publication C-34, a 64-pp catalog, covers use of copper in the pipelines of many industries, including process applications in chemical plants, distilleries and sugar and textile mills, in refrigeration and air conditioning, in mechanical jobs such as pressure lubricating systems and pump equipment, and in plumbing and heating installations. Installations are pictured and described and engineering information provided. Book also discusses low first cost, light weight, rust resistance and other practical advantages of copper tubing. Full data on accessories and fittings included, also instructions for assembling, sizes, weights. The American Brass Co.

106 Strainers and Separators—Bulletin S-40-20A is a revised 16-pp catalog covering manufacturer's Y and T-type strainers, suction strainers, multi-flow and receiver separators. Contains descriptions, dimensions, weights and list prices. Shows how several types have been redesigned for increased efficiency. Includes technical data, also engineering information on flange dimensions and service pressure ratings. American District Steam Co.

107 Electrically Operated Trap—Bulletin ET describes company's Steamtrap for pumping or lifting service or for draining vacuum lines. Explains operation and provides drawings of typical installations. Also tells how this trap is being used to return condensate from high pressure processing equipment back to boiler room at higher temperatures, and how it eliminates heat losses that come with flashing or the addition of cooling water. The Johnson Corp.

108 What's In a Valve?—Vol. 14, No. 2 of Valve Values, company's house organ, tells of new testing techniques in valve design. Also describes and illustrates laboratory devoted to steel research. Includes a handy table showing pressure-temperature rating for steel valves, pipe flanges and flanged fittings—a table just the right size to clip and file or put under the glass on your desk. Edward Valves, Inc.

109 What's Going on Inside?—Eight flow indicators for insertion into pipe lines carrying oil, steam, water, cooling liquids are illustrated and described in Bulletin DD, 4 pp. Covers both cylinder and window types, gives sizes and prices. Also catalogs gage glasses, tubing, safety water columns for boilers, gages and other safety equipment. Ernst Weber Coturan & Gage Co.

INSTRUMENTS AND CONTROLS

110 Fluorescence Detector — Folder 48 describes a new ultraviolet light source with inbuilt dark chamber to make possible fluorescence detection and comparison in daylight. Portability is shown in applications to ore exploration, oil detection, and non-destructive material testing with glow techniques. Illustrations show the self-energized unit in use, an exploded view shows construction and design. Sizes, weights, prices and spectral frequencies of operation are given. Mineo Research Laboratory.

111 Boiler Feedwater Control — Bulletin B-50, 8 pp. describes and illustrates company's one-, two- and three-element boiler feedwater control systems, and features a comparison of the three, discussing the advantages of each. Transmitters, valves and other components of the control systems are described in detail. Republic Flow Meters Co.

112 Flow Tube—Catalog 50, 4 pp. presents engineering data on a new primary element for measuring, regulating and controlling fluid flow. Tells how these flow tubes are designed and how they function and discusses their advantages. Includes test results covering their use on high mass line velocities, medium to low mass line velocities and steam and condensate vapors. Foster Engineering Co.

113 Smoke Alarm—Bulletin 110, 2 pp. describes a low cost smoke alarm for use on coal, oil or gas burning in-

---

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cholesterol. Illustrates lamp and alarm units, methods of installation. Gives specifications, installation tips, ordering information. General Power Plant Corp.

114 Boiler Water Feeder—Outstanding is that thirsty boilers are fed actors, this folder discusses hazards of low water and the protection afforded by company's boiler water feeder and feeder cut-off combination. McDonnell & Miller, Inc.

115 Crankcase Oil Tester—A photo-electric instrument for testing crankcase oil—described as the first of its kind—is introduced in Bulletin 750. Explains and illustrates how the tester works to measure contamination of oil in diesel and other internal combustion engines. Photovolt Corp.

116 Regulator-Filter—Bulletin PH-15-3, 4 pp, describes a packaged unit which combines the features of a reducing relief valve and an air filter in a form adaptable to instrument controller requirements. Illustrated with photos and sectional sketches it discusses the filter, regulator, drip-well, connections, pipes and mountings. Explains how filter works and is cleaned. Includes capacities, dimensions. Conoflow Corp.

STOKERS, COAL AND ASH HANDLING

117 Spreader Stokers—How company's spreader stokers distribute coal over grates and meet firing requirements of individual installations are discussed and illustrated in 4-pp Publication 55. Photos show stoker units, blade and shaft assembly. Operating features are explained. The Standard Stoker Co., Inc.

118 Spreader Stoker Data—This is a file of three illustrated bulletins on company's spreader stokers. The first discusses main reasons for retaining these stokers and describes their design, construction and operating features. The second is devoted to a discussion of the dumping grate mechanism and the third illustrates 15 typical installations. Riley Stoker Corp.

119 Ash Handling Pumps—Catalog 400, 32 pp, covers a line of centrifugal pumps in wide industrial application and especially suited for handling ashes in power plants, as well as abrasive mixtures, slurries, hot and corrosive liquids. Several basic types are described—a horizontal shaft, single-stage side-suction pump; a horizontal shaft, single-stage, rear-entrance automatic priming pump; vertical shaft wet pit pumps with standard and overhead quill bearings, and a vertical shaft dry pit pump with standard bearing. Pumps are illustrated with photos and sectional drawings and full dimensional data are included. Eagle Pumps.

120 Automatic Ash Removal—This 36-pp booklet presents company's pneumatic soot and ash removal systems for handling all furnace refuse from fine dust to cinders and side wall clinkers, dust to sylinders and side wall clinkers, and applicable to stoker or powdered coal installations. Discusses low power and labor costs, low maintenance, flexibility and other advantages of system. Describes and illustrates control unit, vacuum producing unit, ash receiver sections and other parts. Illustrates installations in manufacturing plants, power plants. Chicago Fire Brick Co.

121 Fly Ash Precipitation—This bulletin describes an electrostatic precipitator for removal of either bituminous or anthracite fly ash from power plant gases. Illustrates an installation, also packaged power units. Explains how equipment works and discusses its advantages. Koppers-Elec Precipitator Dept., Koppers Co., Inc.

122 Conveyors at Work—A dozen examples of what modern conveying systems can do—from coal handling installations that make good neighbors of power plants to flour handling installations at bakeries—are described and pictured in Vol. 194 of company's house organ, the SA Conveyor. Also described are centrifugal loaders, plows and other equipment. Stephens-Adamson Mfg. Co.

PUMPS

123 Deep Well Turbine Pumps—Bulletin 4700 is a 20-pp booklet in color, with photos and cutaway illustrations showing construction details, various types of drive and typical installations of company's deep well turbine pumps. Although widely used for pumping water supply from deep wells these pumps have many other applications. Booklet discusses construction of column and shaft, and bowl assembly, stressing special features. Discusses use of these pumps in water works, industrial service, condensate and boiler feed service, and as industrial solvent pumps. The Deming Co.

124 Multi-Stage Centrifugal Pumps—Bulletin 161, 6 pp, discusses company's four- and six-stage pumps designed for long service and low maintenance. Describes construction features and design details and includes cutaway illustrations of a six-stage pump. Metal specifications, full dimensional data included. Warren Steam Pump Co., Inc.

125 Self-Priming Pump—Complete information on company's new line of self-priming centrifugal pumps is presented in Bulletin 6081, 8 pp. Pumps' valveless design is explained and illustrated along with principle of operation. Sizes, capacities. Goulds Pumps, Inc.

MECHANICAL POWER TRANSMISSION

126 Practical Gear Manual—Newly revised Catalog 55 is pocket-size but contains more than 200 pp of information on stock gears and other mechanical power transmission equipment, including new items and applications, charts and ready reference data not given in earlier editions. Also includes product and engineering information, provides formulas, horsepower rating charts, reference labels and selection charts to enable quick figuring of correct power drive. Among products introduced are company's Rex-Bronz oil impregnated, porous bronze bearings. Boston Gear Works.

127 Speed Reducer Catalog—Herringbone speed reducers of the single, double, and triple type, are presented in the 1950 edition of Catalog 78, 128 pp, punched for filing. In addition to general descriptions and product information, this fully illustrated catalog includes dimensions, rating table, service factors and engineering data covering selection and use of variable speed devices. Many installations are pictured. W. A. Jones Foundry & Machine Co.

128 Gear Coupling—This 4-pp bulletin illustrates and explains the simplified seven-part construction of company's gear coupling and compares it with other gear types. A check list of advantages is included, as are photos and descriptions of typical installations. Also provided are detailed plant drawings and specifications for standards, mill motor, vertical shaft, spacer and floating shaft types. Service factors and selection tips are given. Illinois-Basch Gear & Pump Co., Inc.

129 Speed Reducer Data—Engineering Bulletin 1100, offers 16 pp of information on concentric shaft speed reducers, covering their selection, ordering and use. Fully illustrated, includes dimensions and sketch data on minimum sprocket diameters, maximum overhung loads, weights and oil capacities. Also provides torque capacity and horsepower rating tables, AGMA service factors. The Falk Corp.

(Continued on page 111)

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CHICAGO 3, ILLINOIS

First commercial ultrasonic testing of HT-HP power piping shows value of method!

For years power engineers have known that alloy power piping might on occasion contain defects which could not be discovered by inspection methods other than radiography. But rather than adopt the virtually prohibitive expense of radiographing complete lengths of pipe, designers specified relatively high safety factors.

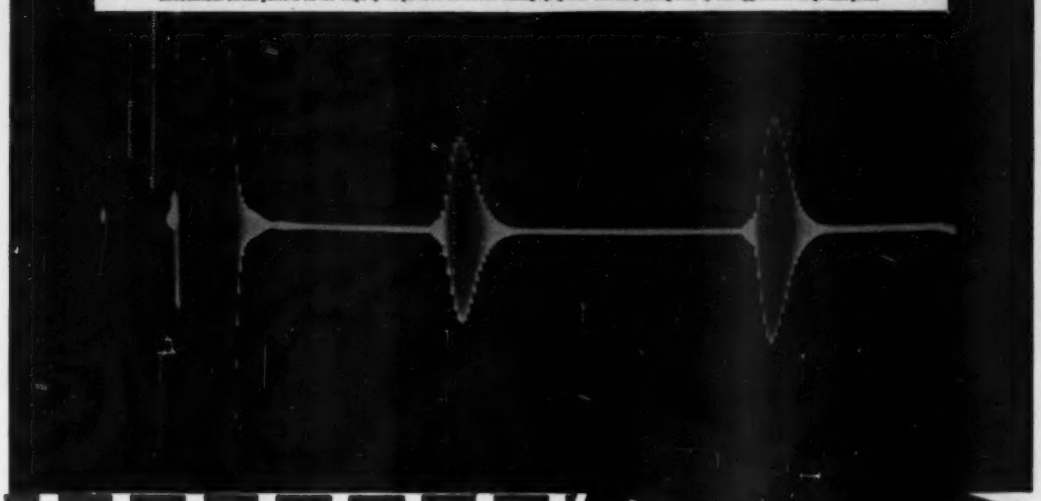
Of course this precaution did not preclude the possibility of defects, and when failures have occured, subsequent investigations have shown that internal cracks were usually the cause of the ruptures.

To meet this problem, investigations were made of inexpensive, non-destructive pipe inspection methods which could reveal hidden defects, and late in 1949, Kellogg, in cooperation with a large turbine manufacturer, presented a practical solution with the introduction of commercial ultrasonic testing of alloy piping.

Ultrasonic exploration of materials, although known for several years, has only recently been attempted on power piping. Indications now are that this technique will prove a successful and low cost means for discovering flaws and, furthermore, for putting a finger on them with startling accuracy. In view of the steadily increasing temperatures and pressures demanded by the economics of modern power generation, the value of this development is obvious.

Specific and continuing studies of this nature are among the many advantages that utility companies gain when they specify high-temperature and high-pressure piping fabricated by M. W. Kellogg.

Illustrated: Screen pattern on the 'scope of the portable ultrasonic testing equipment currently being used by Kellogg in both shops and field.



Special studies of unusual problems such as graphitization to assure long life and low maintenance.

Metallurgical research by recognized specialists who have made major contributions in this field.

M. W. KELLOGG

Exclusive Equipment for accurately analyzing stresses in piping and providing unique data for critical installations.

Complete facilities for the fabrication of steel products from simple forgings to specially cast bi-metallic devices.

Top welding performance in shops and in the field by welders accustomed to working under X-Ray checks.

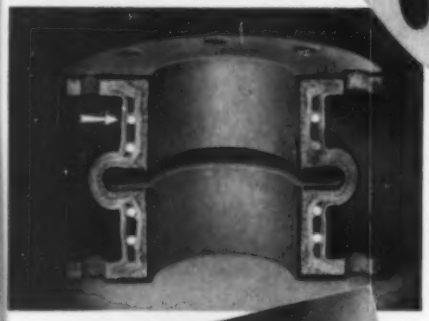
Quality control, devised by metallurgical experts, embracing forming, heat treating and non-destructive testing.

Vessels
Exchangers
Condensers
Process Piping
Forged and Welded Fittings
Radial Brick Chimneys

The M. W. Kellogg Co., Inc. (Subsidiary of Pullman, Incorporated)—Offices in New York, Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London and Paris

STANDS UP under Repeated Flexing!

Note sturdy construction. The arrow in photo below points to one of the steel reinforcing rings.



GARLOCK RUBBER EXPANSION JOINTS

resist cracking and corrosion— and do not take a permanent set

GARLOCK RUBBER EXPANSION JOINTS hold up under repeated flexing caused by expansion, contraction and vibration of the pipe line, because they are constructed of high grade rubber which is combined with plies of sturdy cotton duck and reinforced with steel wire or rings. Where oil resistance is necessary, neoprene joints are available.

For all pipe sizes from 2″ to 72″, including tapered joints. Specify No. 204 for *Pressure;* 205 for *Vacuum;* 206 for *Pressure and Vacuum.* Write for descriptive folder.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

GARLOCK

UNIT TANDEM

YARWAY'S Answer to High Pressure Blow-Down Requirements

As pressures increase, so does the demand for dependable blow-off valves to meet these needs.

The Unit Tandem is Yarway's answer . . . proved by hundreds of successful high pressure installations in leading utilities and industrial plants.

This blow-off valve, combines the worth-while improvements and advances both in metallurgy and mechanical design.

Unit Tandems are built for pressures to 2500 psi.

Inside (next to boiler) blowing valve is the Yarway Stellite-Seat valve.

Outside sealing valve is the famous Yarway Seatless design which has no seat to score, wear and leak. This valve is always opened first and closed last, maintaining a tight seal at all times.

Write for Yarway Bulletin B-432 for complete description of this Unit Tandem. For lower pressures ask for Bulletin B-424.

YARNALL-WARING COMPANY
114 Mermaid Avenue, Philadelphia 18, Penna.

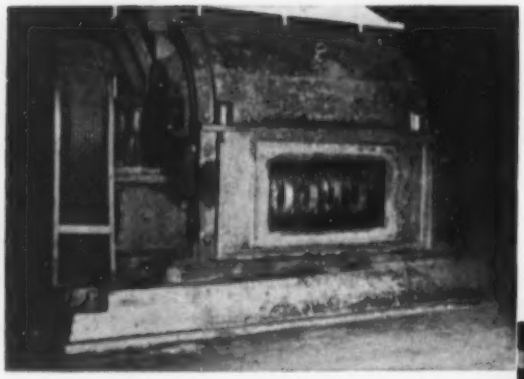
YARWAY

BLOW-OFF VALVES

PROVED Champions of Quality...

AMERICAN CRUSHERS handle high tonnage for years with *amazingly* LOW *parts replacement costs!*

The most convincing proof of American Crusher *quality* can be obtained by comparing *cost of replacement parts needed* to *tons of coal crushed* in specific operations. Taken from an extensive independent survey of users, the following case analyses are typical —

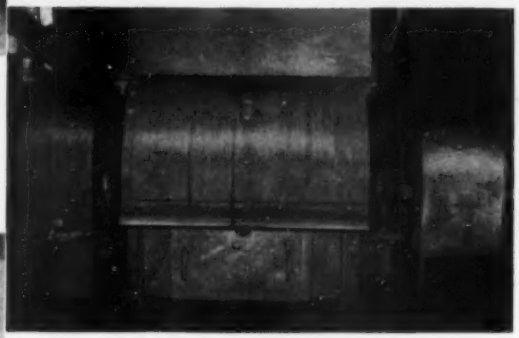


A Power Plant in Illinois

TYPE CRUSHER: AMERICAN 42S
YEARS IN SERVICE: SIX
TONNAGE HANDLED: 2,950,000
PARTS COST PER TON: $ .0004

A Central Station in New Jersey

TYPE CRUSHER: AMERICAN 42S
YEARS IN SERVICE: TWENTY
TONNAGE HANDLED: 6,000,000
PARTS COST PER TON: $ .00025



An Industrial Power Plant in Ohio

TYPE CRUSHER: AMERICAN 15C-1
YEARS IN SERVICE: NINETEEN
TONNAGE HANDLED: 182,000
PARTS COST PER TON: $ .0000

These typically low parts cost figures are revealing —*they help to explain why American Crushers can reduce coal for less than 1 cent per ton even when all other operating costs are included!*

Write for literature on AMERICAN CRUSHERS

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

1429 MACKLIND AVE.
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COMPLETELY DEIONIZED WATER IN ONE PASS THROUGH ONE UNIT!

Get full details of the technique that's revolutionizing water treating.

Once through a *single* bed of AMBERLITE ion exchange resins, and your water supply is rid of silica, carbon dioxide, calcium—*all* ionized solids!

AMBERLITE Monobed deionization is fast replacing multiple-bed methods of producing high quality water for boiler feed, electroplating, deposition of phosphors, washing of photographic film.

The column on the right will tell you *why*.

Consulting engineers and manufacturers of water conditioning equipment can tell you *how* Monobed deionization insures the life and efficiency of your boilers, improves your process and your product.

Our new 12-page booklet tells you *what* AMBERLITE Monobed deionization is. Write to Dept. PEI-8 for your copy—today.

AMBERLITE Monobed Deionization Offers You . . .

1. Low equipment costs
2. Low operating costs
3. Extreme ease of operation
4. Uniform performance in intermittent service
5. Controlled quality of effluent

CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION

Washington Square Philadelphia 5, Pa.

The Resinous Products Division was formerly The Resinous Products & Chemical Company

AMBERLITE *is a trademark, Reg. U.S. Pat. Off. and in principal foreign countries.*

NEW EQUIPMENT NEWS

WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other information desired. For ease in making requests use the no-obligation, postage-paid card pages 35-36.

1—ION EXCHANGE RESIN

Is medium capacity phenolic type, furnished in granular form

Now available commercially is Amberlite IR-105G. Company says its high regeneration efficiency makes it particularly adaptable to hydrogen cycle operation, and especially useful in deionization and split-stream dealkalization. In the sodium form it is suitable for water softening.

This new phenolic resin is announced as combining the excellent hydraulic behavior of company's Amberlite IR-100 and the high capacity and regeneration efficiency of IR-105. It replaces these in company's series of ion exchange resins. Resinous Products Div., Rohm & Haas Co.

2—BLEED VALVE

Continuous type, is adjustable to permit any required flow

This continous bleed or boiler blow-off valve has an indexing control disc with 15 calibrated orifices which may be quickly adjusted to flow requirement. Each orifice is indexed and numbered to correspond to a flow chart provided with the unit.

A sediment chamber is located before the valve to prevent plugging the orifice and a velocity reducing chamber absorbs erosive high-velocity jet of liquid ejected from the open orifice. Samples may be taken from a ½ in. cock on the velocity reducing chamber. Unit weighs 40 lb, is hydrostatically at 1000 psi before shipping. The Uniblow Valve Co.

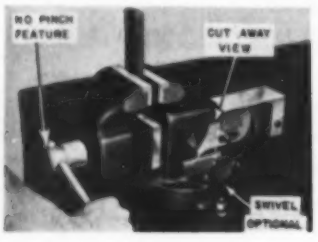
3—MACHINIST'S VISE

Offers fast slide action and a non-pinch handle feature

A real time-and-motion saver, the Slide-Set Vise opens or closes to any position through a push-pull action which eliminates spinning the handle.

The slide action is simple. Give the handle a turn and a half counter-clockwise and the jaw slides in "neutral" to any position. Then, as soon as the work is engaged, you give the screw only a short, final tightening in the usual way.

The handle is specially designed to keep the operator from getting his hand pinched between thumb and forefinger if he lets the handle drop. Vise is built of high-strength steel parts and semi-steel castings in 4 in. size. It weighs 58 lb and is available with either swivel or stationary base. Dodge Mfg. Corp.



4—SELF PRIMING PUMP

In sizes from ¼ to 5 hp, available with open and closed impellers

This new line of centrifugal self-priming pumps may be had in capacities to 120 gpm and heads to 135 ft, depending on capacity, and suction lifts to 25 ft. Manufacturer stresses that their design affords positive self priming and incorporates no valves, no large reservoir, no recirculation of water during pumping stage. Goulds Pumps, Inc.

5—DEMAGNETIZING COIL

For demagnetizing materials, and stabilizing magnetic flux

Any unshielded magnetically soft materials, including forms of iron and steel, can be demagnetized by this instrument, according to company engineers. They suggest its use to eliminate undesirable magnetic flux from tools, drills, punches and machined parts that may have become magnetized.

The demagnetizer is also useful in equalizing and stabilizing magnetic flux in permanent-magnet assemblies used in electrical instruments and control devices.

Shipped complete and ready for use, it consists of an air-core built in a frame which can be mounted on any bench. Coil is rated at 115 v, 60 cycles and equipped with switch, pilot lamp and flexible head fitted with standard plug. Its rectangular opening, 4½ by 8½ in., accommodates stock up to 8 in. wide. Special Products Div., General Electric Co.

6—THERMOMETER TESTING SET

Nine matched thermometers with overlapping ranges; choice of scales

Instruments included in the TAG ASTM Certified Thermometer Testing Set are available in either Centigrade (Celsius) or Fahrenheit scales. They're described as relatively inexpensive and highly accurate.

Inclusive ranges of each set are: -36 to 760 F, or -38 to 405 C. Calibrations are in 1/10, 1/5 and ½ deg for the Centigrade scales, and 1/5, ½ and 1 deg for the Fahrenheit. Thermometers are heavy glass, 15 in. long, 7 to 8 mm dia. Set is packed in plush-lined case. Tagliabue Instruments Div., Weston Electrical Instrument Corp.

7—GENERAL SERVICE PUMP

Is designed to afford utmost simplicity of maintenance

The GS Pump has been designed from the ground up to fit company's service and exchange plan. All parts, except casing, are contained in the rotor assembly. When maintenance is necessary you simply remove the cover and end plate studs, lift out the assembly and drop a new one in place.

New rotors are ready for immediate shipment from stock, and when you return the old one you get full credit for all serviceable parts. Or, you can exchange the entire pump for a factory-rebuilt one, with credit for parts.

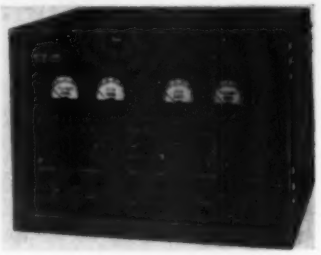
Plants with their own maintenance crews and stocks of spare parts will find this pump design convenient. Casing is horizontally split for easy access without breaking piping connections. Parts are interchangeable and available for shipment from factory.

Other features of the pump are simple mechanical seals and pre-lubricated bearings. Furnished in three capacity sizes for capacities to 450 gpm, heads to 230 ft. De Laval Steam Turbine Co.

8—POWER SUPPLY UNIT

Is cabinet mounted, designed to afford dual voltage regulation

The Model 510 features two completely independent voltage regulated power supplies with low ripple content, low output impedance, fuses on input and output circuits and output current and voltage meters. Each d-c output voltage is continuously variable from 200 to 500 v, 0 to 200 ma.



Output voltage variation is given as less than 1 per cent for both line fluctuation from 105 to 125 v and load variation from minimum to maximum current. Each a-c output is 6.3 v, 6 amp, center tapped, unregulated. Power requirement is 600 w. D-c outputs may be used separately, in parallel, in series and bucking.

Cabinet is 14 in. high, 21 in. wide, 14¾ in. deep. Unit may be removed from cabinet for standard relay rack mounting. Kepco Laboratories, Inc.

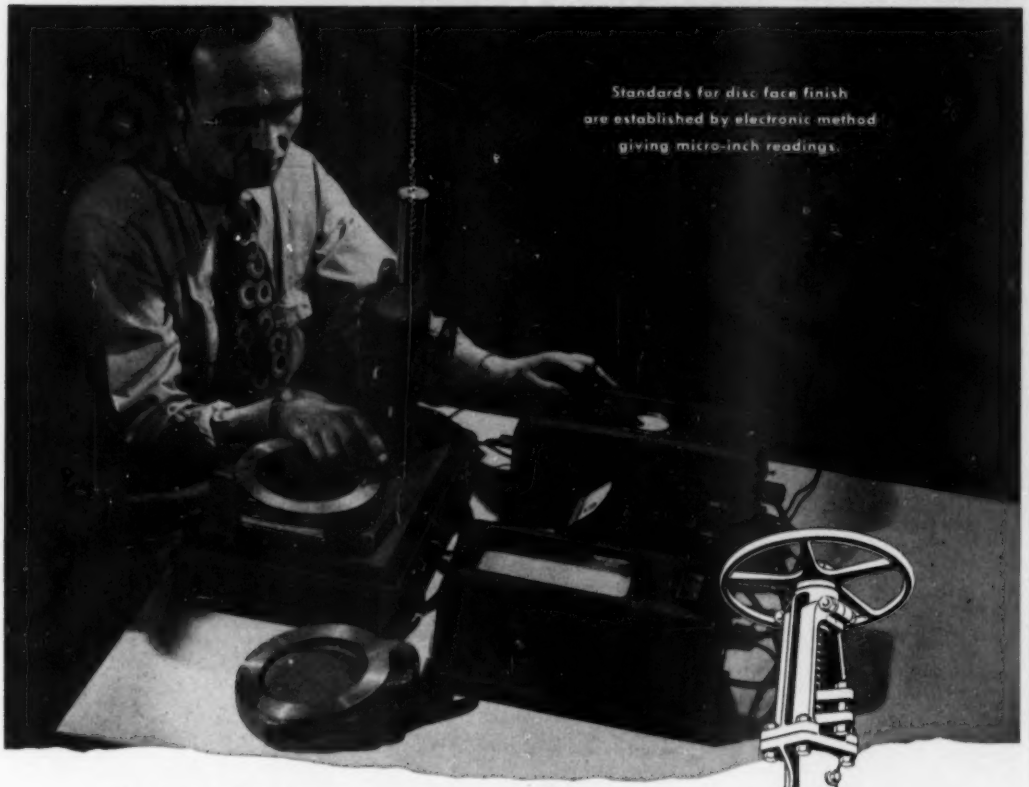
9—WATER TREATING SYSTEM

For boiler feed water, combines features of hot and zeolite processes

The development of a styrene base resinous zeolite suitable for operation on hot treated water is credited with making possible the Hot-Z System—a combination of hot process treatment with its deaerating and silica reduction, and zeolite softening for uniform hardness reduction without the addition of excess sodium alkalinity.

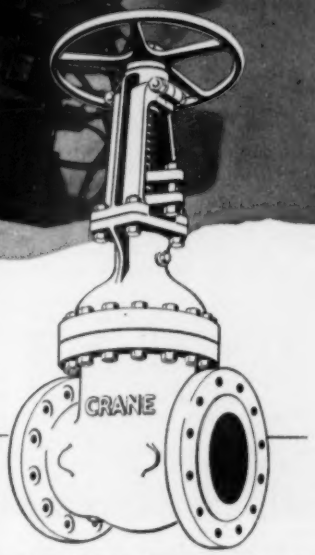
In effect, the temporary hardness is

More **CRANE VALVES** are used than any other make



How CRANE controls quality to the Micro-Inch to cut your valve costs

Surface finish of a valve's working parts has a lot to do with its wear resistance and operating efficiency. A correct finish means a tighter-seating valve, easier operation, greater ease of maintenance. In Crane Quality valves, the surface finish of machined parts is measured and controlled to rigid limits. The standards for quality control of surface finish are determined by the most scientific methods as shown above. Yes, nothing is overlooked to make Crane Valves the lowest-cost valves in the long run. *That's Crane Quality!*



Precise quality control of materials, design, and manufacturing—to the highest degree in the industry—makes Crane valves the lowest cost valves in the long run. On steam service, oil and oil vapor lines, for example, you'll find Crane Steel Gate Valves a sure remedy for high maintenance costs. Talk it over with your Crane Representative.

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Ill.
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VALVES • FITTINGS • PIPE • PLUMBING • HEATING

removed by lime and zeolite treatment, while the zeolite removes the permanent hardness. The system substitutes zeolite salt for more expensive chemicals customarily used for removal of permanent and residual hardness in hot process softening.

Since zeolite must be backwashed with clear water and, less frequently, regenerated with salt solution, a separate annular wash water compartment is provided in the hot softener tank to insure hot water for backwashing. The salt regenerant is brought up to temperature by steam heater. Water Treating Div., Worthington Pump and Machinery Corp.

10—CARTRIDGE TYPE SWITCH

For control of electric circuits by hydraulic pressure actuation

The Pantex Hydraulic Pressure Electric Switch is designed to cut-in and cut-out electric circuits with as little as 12 to 18 per cent pressure differential. It is unaffected by pressure surges, temporary or sustained, company reports, and has withstood a temperature differential from -65 F to 160 F without loss of accuracy.

The design of this unit is intended to eliminate failure due to either mechanical or hydraulic shock. It operates with every start of the pump—requires no pressure build-up. It's small, lightweight, silent and easily adjusted without breaking the line. Pre-set switch limitations are available if desired. Hydraulics Div., Pantex Mfg. Corp.

11—PRESSURE FLOW CONTROL

For automatic regulation in pumping of liquids, oil, gas, sewage

The Pressureflo Control may be used to start and stop pumps; increase or decrease speed of one or more pumps; maintain predetermined pressure at any point or district on a distribution system, or automatically adjust both the pressure and flow to suit varying demands.

Control consists of a flow-determining means, a pressure or level sensing device and a mechanism to translate this into a control function. Metering devices are normally desirable on any system, and other equipment includes standard components and a special device to convert flow and pressure into pump response.

Reduced power costs resulting from more efficient pump operation, and reduced maintenance are among the economical advantages cited for this control. It may be applied to any existing or new distributing system and requires no special design of pumping station, no external control circuits. Builders-Providence, Inc.

12—TRANSFER MECHANISM

Works automatically, permits remote control of feeder selection

Designed for use with company's load break oil switches, the Model E6 is used with either a double throw switch or two single throw switches, supplying one load from either of two feeders. The mechanism is designed to automatically transfer load from preferred to emergency feeder, on failure of the preferred, and back to preferred feeder as soon as it is reenergized.

Also provided in the Model E6 is operator selection from remote location. Operator can transfer the load at will between the two feeders to balance them during peak demand, or to isolate one for maintenance.

Mechanism is enclosed in sealed housing which is mounted directly on the supporting frame of company's Type RA switches in 5000, 7500 and 15,000 v ratings. G & W Electric Specialty Co.

13—STUD PULLERS

Threaded collet type removers, inserters; can be used in limited areas

Two new series of steel stud pullers include a smaller unit with 14 different collets available to handle studs from ¼ to ⅝ in. dia in both fine and coarse thread sizes; the larger model has six collets for ¾ to 1 in. dia studs.

Operation is simple . . . correct thread size collet to fit the thread of the stud is inserted in the housing, and the hole unit threaded over the stud. Turning top bolt draws the slotted tapered collet up into the housing compressing it and locking it onto the stud threads. Collets are keyed to prevent turning inside the housing. Once the tool is locked onto the stud the whole assembly can be turned with a socket or open end wrench.

Outside diameters of the units are only 1⅜ and 2¼ in. and as both turn on center they can be used where little clearance exists. Snap-on Tools Corp.

14—CONTROL CENTER

Is designed to provide control for more motors in the same space

As many as six Size 1 or 2 starters can be mounted in a standard vertical section (20 in. wide, 20 in. deep and 90 in. high) of these newly designed Plug-In Control Centers. They also include new safety handle mechanisms, circuit breakers, starters and switches.

Plug-in units have positive pressure stabs which grip round vertical busses. Units slide on corner guide rails for easy removal or exchange. The safety handle mechanism provides for up to four padlocks to lock both doors and disconnect in "on" or "off" position. Square D Co.

15—CONDENSATION PUMP

Is compact and sturdy; two bolts anchor it to the floor

The Type CHV Condensation Pump takes less room than many pumps of comparable size and it's easy and economical to install. Electric motor units are supported by the heavy-gage copper-bearing steel tank and motors are mounted well above the floor level.

Single or duplex units are available in capacities from 2000 to 20,000 EDR. They're ready for operation after piping and wiring connections are made. C. A. Dunham Co.

16—PLASTIC PACKING

Has tape back to increase flexibility, prevent breakage when installing

A vulcanized tape back is now an integral part of company's Super Seal Spiral Packings. Ring cutting is simplified with this type of reinforcement because the spiral can be twisted down to small shaft sizes and then cut into rings without breakage.

Packings come in six types, each marked in a different color for ready identification. Described as resilient and homogenous, they're composed of asbestos, anti-frictional metal particles, flake graphite and binders. Company says they do not harden at high temperatures and need not be removed as wear occurs, the addition of another ring to the stuffing box being sufficient to maintain leak-proof service. Crane Packing Co.

17—GRIPPING CHUCK

Is automatic work holding device for use on pipe threading machines

The Auto-Grip Chuck eliminates use of chuck bars and T wrenches on all of company's 2 in. pipe threading machines which revolve the work. Its gripping action is said to be equally effective on all kinds of pipe, including steel, iron and galvanized.

The operator spins the chuck's hand wheel until the jaws strike the pipe, then starts the machine. The jaws grip the pipe automatically. The tougher the pull, the tighter the grip. Company says this chuck makes the operation of chucking pipe both faster and safer. The Oster Mfg. Co.

18—THROTTLING VALVE

For use in high pressure, corrosive, or erosive applications

This is described as an easily-operated venturi ball valve featuring straight line discharge characteristics. In throttling position the ball presents a smooth surface and non-turbulent flow is possible over a wide range. Wide open flow is unobstructed, non-turbulent with negligible pressure drop, company says, and when tightly closed the ball seats tightly regardless of pressure and flow conditions.

The venturi design promotes self-cleaning and purging since liquids or gases passing through the venturi passage suck out dirt, scale and sediment. Ball seats in different position each time, distributing wear over entire surface. There are two seats and valve may be reversed in the line to extend its service life. Valve is available in different materials, depending on service requirements. W-K-M Co.

19—VAPOR STEAM GENERATOR

Supplies high pressure steam for short or sustained periods

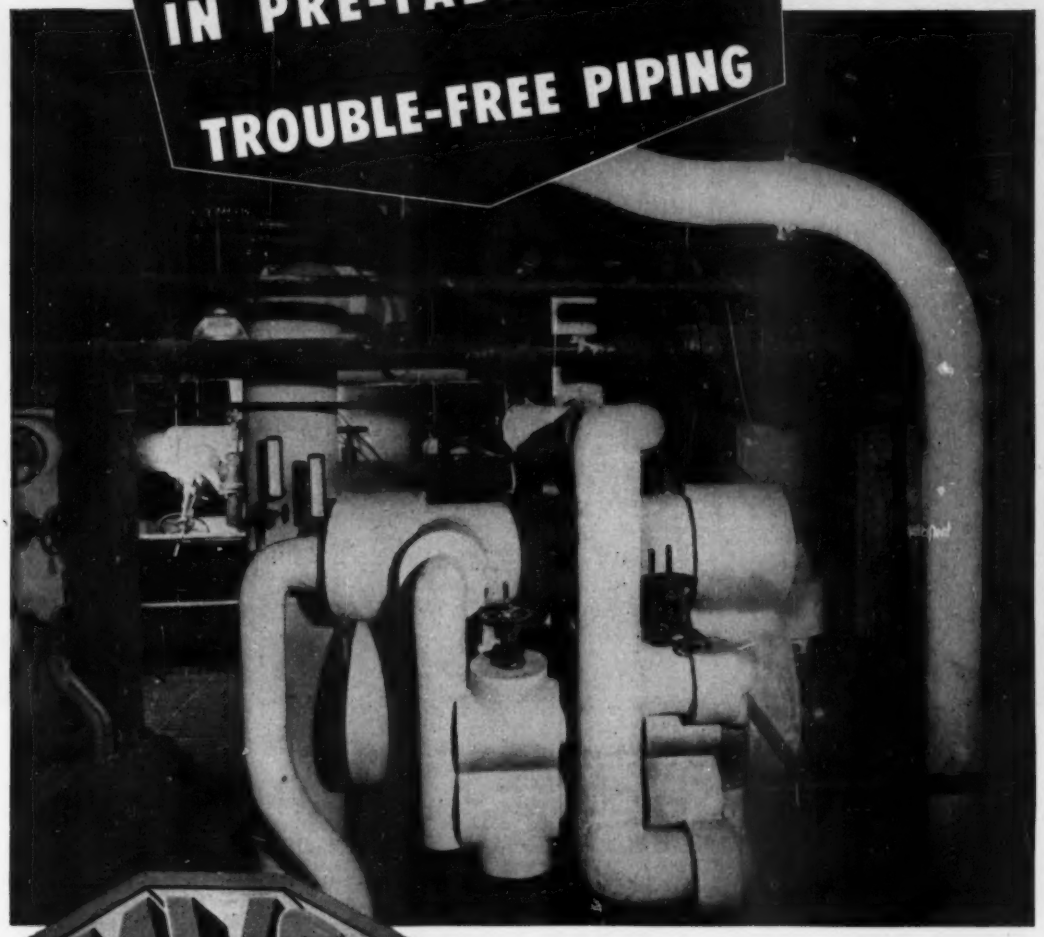
The portable Model 4635 is engineered to develop 200 lb working steam pressure in 2 min from cold water, and to make over 3500 lb of steam an hour, at 75 to 300 lb steam pressure. This is done by hot gases from a forced draft fuel-oil fire wiping over a 575 ft steel coil.

New features incorporated in this generator include an economizer coil in the path of exhaust gases to increase output and efficiency and relocation of motor to shorten the unit.

Steam is made as needed. Once started, automatic controls cause machine to turn off when predetermined steam pressure is reached, then on again when steam pressure drops 15 lb.

A 5 hp electric motor or gas engine supplies power to drive the water pump, blower, ignition and fuel pump. Machine, including steam reservoirs, is 8 ft long, 4 ft wide and 6½ ft high. Vapor Heating Corp.

NAVCO ACCURACY IN PRE-FABRICATION TROUBLE-FREE PIPING



NAVCO

Prefabrication accuracy is an essential "MUST" to assure a proper fit and economical operation. Navco's 40 years' experience in fabricating assemblies in all sizes and for all operating conditions is your assurance of such accuracy.
Consult Navco for your next piping job.

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NATIONAL VALVE & MANUFACTURING COMPANY • PITTSBURGH, PA.

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CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

ELECTRICAL

201 **D-C Generator** — Illustrated Bulletin 05B7229, 20 pp, describes the construction of units larger than 150 kw or 0.3 kw per rpm, including two- and three-wire generators and exciters, both engine and coupled type. It also discusses the operation of shunt wound and compound wound generators in parallel, and supplies information on company's marine units. Includes description of "frog leg" armature winding widely used on motor-generator, set generators of 100 kw and larger, synchronous converters of 200 kw and larger and large low speed generators. Allis-Chalmers Mfg. Co.

202 **Synchronous Motors** — High speed synchronous motors are described in 4-pp bulletin PB 5600-1. The bulletin is packed with descriptive matter and photographs explaining features of the motors rotor and stator. Mechanical modifications also are illustrated. Elliott Co.

203 **Low-Speed Synchronous Motors**—Publication GEA-5332, 8 pp, illustrates typical installations of efficient high-power factor, constant-speed drives, describes their construction features, and indicates mechanical modifications and performance data. Covers three-phase and two-phase motors in company's "600" series with frame sizes of 6184 and larger and ratings from 20 to 15,000 hp. Photos show detail of stator and rotor design. General Electric Co.

204 **Care of A-C Rotating Equipment**—To promote intelligent and consistent maintenance of electrical machines, company has published Bulletin 05R7417, which is a series of articles by Fraser Jeffrey. Contents of the 24-pp booklet cover preventive maintenance and machine repairs, and include such subjects as drying moist insulation, measuring insulation resistance, bearing clearances and proper machine applications. Machine repair chapters include data on stator coil and slip ring rotor repairs, balancing of rotating equipment. Allis-Chalmers Mfg. Co.

INSTRUMENTS AND CONTROLS

205 **Smoke Density Recorder** — Bulletin 211, 4 pp, tells how company's bolometer-type smoke density recorder promotes efficient furnace operation and how it helps in the battle against smoke nuisance. It describes and illustrates the smoke detector which consists of a bolometer receiving and measuring radiation from a sealed beam light source. Recorder specifications, installation requirements, and measuring circuit details are also discussed. Bailey Meter Co.

206 **Boiler Water Level Control** — Bulletin 487 describes completely the installation of boiler water level control equipment at the Blackhawk Generating Station, Wisconsin Power & Light Company. Photographs of the installation are presented as is a schematic layout of the entire station along with tabulated significant data. Northern Equipment Co.

207 **Instrument and Control Panels** — Bulletin 773, 8 pp, explains how company's panels are made and where they are used. All operations of fabrication are discussed and illustrated—layout, cutting, drilling, welding, fitting, painting, wiring. Panel features like electric clocks, pressure gages, transformers, name plates, push-button stations and signal lights are discussed. Also includes many photos of panel installations covering all sizes, shapes and designs. The Hays Corp.

208 **Remote Reading Flow Meters**—Data Book 702, 32 pp, fully illustrates and explains flow measurement problems and offers suggestions for their solution. Meter bodies, differential devices and reading instruments are fully described and a special section is included on wide range and reverse flow. Numerous illustrations relate an informative pictorial story on fluid flow measurement. Republic Flow Meters Co.

209 **For Practical Men**—That's the title of this 24-pp pocket-size booklet presenting insulation testing in simple language. Packed with maintenance hints, it explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester and justifies its cost in terms of long run economy and prevention of shutdowns. Discusses the Megger as a trouble-shooter, pointing out its functions and telling how to get the most out of it. There's also a chapter on handling wet equipment. Photos, line drawings and humorous sketches accompany the text. James G. Biddle Co.

210 **Flow Meters**—Bulletin 400-F2, 8 pp, features company's meter for measurement of steam, air, or gas flow in 1 or 1½ in. pipe lines, and designed for installation directly in the line being metered. Illustrated with photos of meter, sectional and dimensional drawings, the bulletin explains how meter operates and discusses its advantages. Gives typical specifications and includes correction factor charts and capacity tables. Builders-Providence, Inc.

211 **Pneumatic Metering Element**—Company's pneumatic machine used as the metering element in the measurement and control of steam, gas and liquid flow, liquid level, pressure differential and similar applications, is illustrated and described as to application and operating characteristics, in Bulletin 2150. Design and operation of the machine are shown in full color drawing. Dimensional, ordering data included. Hagan Corp.

212 **Water Gages** — Eight-page Bulletin E-1 covers line of water gages for stationary and locomotive boilers, marine and refinery service and tanks for all pressures and temperatures. Listings include photos of all gages, sizes and construction details. Bulletin S-2, 4 pp, covers gage glasses, glass guards, sight flow indicators. Ernst Water Column & Gage Co.

213 **Temperature Measuring Instruments** Catalog ND4-33-461, 34 pp, describing the company's instruments for measuring the temperature of generators, motors, condensers and transformers, covers a wide variety of instruments, portable and automatic indicators, for checking in any order on temperatures. Reference also is made of new and specialized instruments for measuring in rapid succession a number of bearing temperatures. Leeds & Northrup Co.

VALVES, TRAPS, PIPING

214 **Piping Materials Catalog**—Corrosion resistant valves and piping materials are covered in illustrated circular No. 320, 32 pp. Contains information on manufacturer's complete line of valves, fittings, fabricated piping and pipe coils to meet a wide range of corrosive conditions. Listing includes both photos and cutaway drawing of models, complete specifications, sizes and prices. Includes a description of alloy metals used and a corrosion questionnaire. Also included are condensed recommedations on the selection of piping materials according to service requirements as well as a pictorial chart showing basic types of valves with names of their parts. Crane Co.

215 **Valves Bulletin** — Catalog Section 12-H describes various types of company's cast steel pressure-seal bonnet valves. Information on choosing the best size valve for your service is given in one page of the booklet under the title, "Correlation of Valve Size and Pressure Drop." Design and construction advantages of the valves are given and tables of pressure and temperature ratings. Details of design including operating mechanism, body design, disk piston, and other features are explained. Dimensional details are given in tabular form accompanied by dimensional line drawings. Edward Valves, Inc.

216 **Control Equipment**—General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Catalog illustrates and describes in detail: venturi tubes and meters, controllers, gages, manometers, pitot equipment. Includes capacity tables, dimensional data, specifications, layout drawings. Simplex Valve and Meter Co.

217 **General Service Valves** — Bulletin E-160, 16 pp, describes and illustrates the design and construction of company's quick-operating valves, explaining their application to blow-off service and on fire protection, chemical process, soot blower, water column blow-down, and other types of pipe line. Included are tables of dimensions, weights and list prices for straight lever and rack-and-pinion types, inside packed and with outside stuffing box and with screwed or flanged ends. Everlasting Valve Co.

218 **Unions and Fittings** — Twelve-pp Catalog 56 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special construction features and other advantages. Also illustrates all equipment offered, along with sizes, materials, current price list. E. M. Dart Mfg. Co.

219 **More Data on Strainers**—In response to demand this revised edition, Bulletin S-203, 6 pp, contains greater and more up-to-date data on screwed strainers as well as expanded details on flanged types. Fully illustrated with photos of the strainers and screens used in them, it explains function of the strainers and provides material specifications, pressure and temperature data, dimensions and prices. Also tells how to install strainers and replace screens. Yarnall-Waring Co.

220 **Welding Fittings and Flanges**—Catalog and Engineering Data Book 211, a 262-pp manual, provides complete dimensional data, weights and prices on company's welding fittings and flanges. The engineering section contains practical, illustrated information covering welding fittings and flanges under varying conditions of temperature and pressure, location and materials processed. Discusses their use in different piping systems.

A section is devoted to welding fittings and flanges in special metals and alloys. The technical section covers properties of pipe, rating of pipe, fittings and flanges, line expansion and flexibility, support and anchorage of piping and flow of fluids.

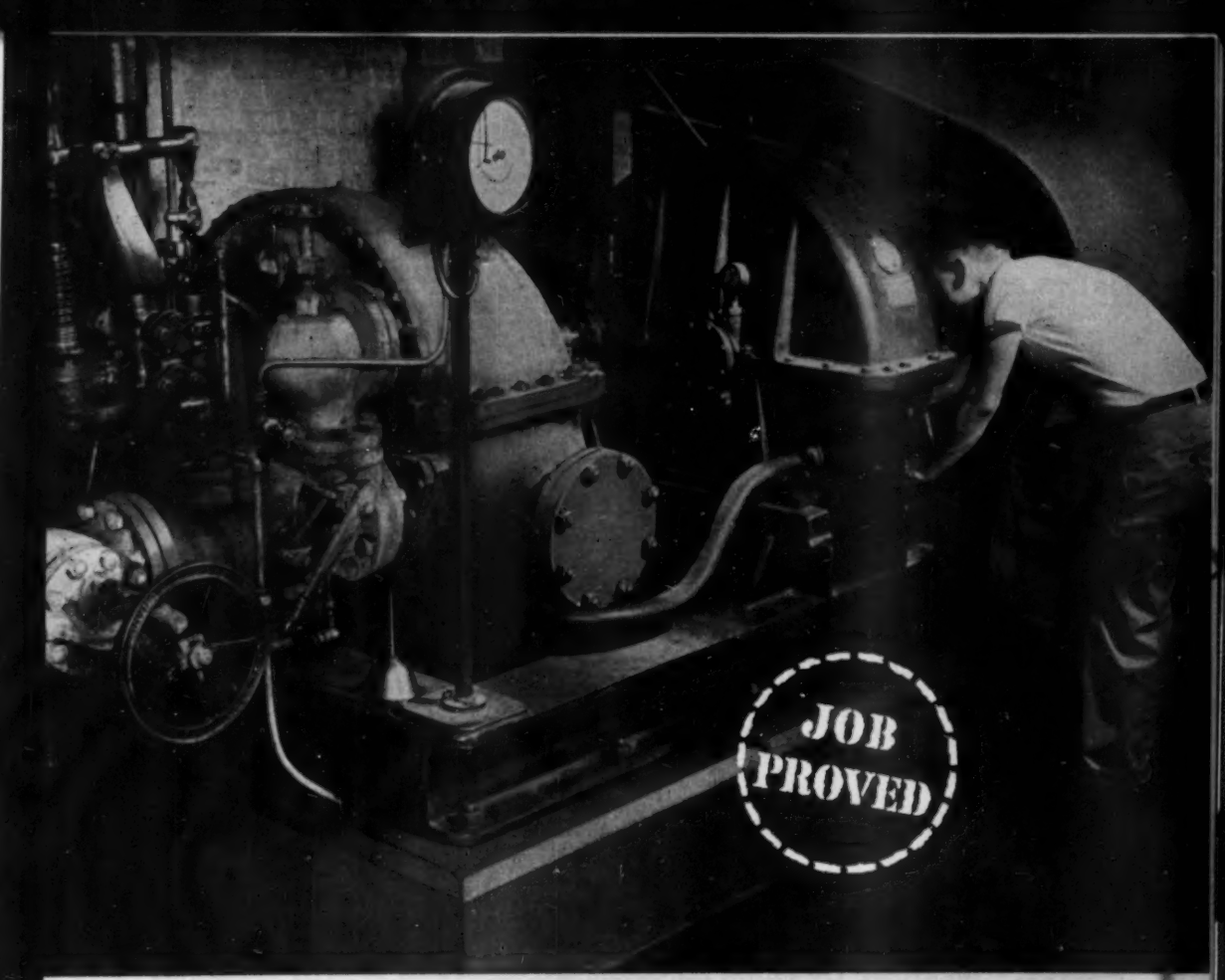
Distribution of this catalog is limited to major users of industrial piping. (Please include your title when requesting it.) Tube Turns, Inc.

221 **Steam Traps and Temperature Controls**—Here is a comprehensive catalog comprising many of company's bulletins on steam traps and related equipment, including an illustrated steam trap chart for easy selection of the right trap for each application. Provides data on boiler steam traps, air eliminators, thermostatic steam traps and air vents, inverted bucket steam traps, temperature regulators and cooling controls, steam and water mixers, thermostats and strainers. Generously illustrated with photos, engineering drawings, catalog contains full dimensional and application data, prices. Sarco Co., Inc.

222 **Steam, Air, Gasoline Traps**—Th's 32-pp illustrated catalog, No. 250, describes five types of thermostatic steam traps for pressures to 225 lb; expansion steam traps for pressures to 250 lb; weight-operated traps for steam, air and gasoline service, pressures to 1500 lb; piston-operated steam traps for pressures to 650 lbs, and also steam, air and gas separators. Includes capacity tables, installation diagrams as well as a discussion of typical applications, and a section giving data, charts and formulas for determining proper size trap. W. H. Nicholson & Co.

223 **Handbook on Fittings and Flanges** —Catalog wf-1950, 83 pp, is packed with working information on manufacturer's seamless carbon steel welding fittings and forged steel flanges. In addition to presenting standard schedules with their specifications, list prices and sizes, this book gives information on dimensional tolerances; American standard flange facings with dimensions; thread standards and threading practice; service pressure ratings, physical and chemical requirements for flanges, nuts and bolts; plus sizes and wall thicknesses of welding fittings stocked in other metals such as stainless steels, Inconel, pure nickel or Monel, aluminum, deoxidized red brass. Grinnell Co., Inc.

224 **How to Choose and Use Air Traps** —Bulletin 202, 4 pp, describes manufacturer's complete line of air traps, covering their selection and installation for automatic drainage of moisture from compressed air intercoolers, aftercoolers, receivers, separators, and drip points. Illustrations of the various airtrap models, their



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The Sunvis "900" Oils have fully justified this confidence, saving the mill 25% or more on lubrication costs. Furthermore, the papermaker knows his equipment—running or idle—is fully protected from rust and corrosion.

Sunvis "900" Oils are *good for the life of your production equipment*. Coupled with the know-how of the Sun representative who calls on you, they are good for your pocketbook, too. For more information, send for a copy of the illustrated booklet "Sunvis '900' Oils". Write Department PN-6.

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applications and how they work are also presented, and physical data and prices included. Armstrong Machine Works.

225 **Rubber Expansion Joints** — Eight-pp Bulletin AD 137 tells about the application, construction, styles, service and advantages of the company's line of rubber expansion joints. Includes ordering information and a table of dimensions which is accompanied by dimensioned line drawings. The Carlock Packing Co.

226 **Flanges for Severe Service** — This 4-pp bulletin describes and illustrates a flange specially developed for services involving severe abrasion and corrosives, and for use in suction and discharge service. Photos and sketches illustrate the flange and its parts. Bulletin also covers a flexible rubber pipe for use with abrasive or corrosive material, as well as an acid- and corrosion-resistant duct, listing solutions this duct will handle. Goodall Rubber Co.

BOILERS AND AUXILIARIES

227 **Working Pressure Data Card**—Maximum allowable working pressures for water tube and fire tube boilers are compiled in a handy reference table, Technical Data Card No. 113 A. It lists pressures in pounds per square inch for seamless and electric resistance welded carbon steel tubes or nipples for different diameters and gages of tubes conforming to ASME specifications. Chart is punched for binding. The Babcock & Wilcox Tube Co.

228 **Dowtherm Vaporizer**—Bulletin No. 48-2, describing manufacturer's Type "A" Dowtherm Vaporizer tells how this unit is designed to evaporate Dowtherm in such a way as to provide dependable operat on at maximum temperatures, discussing its construction advantages in detail. It is illustrated with photos of the vaporizer and includes a dimensional drawing, vaporizer chart and specifications. Also included is table showing general properties of Dowtherm "A." The Wickes Boiler Co.

229 **Tube Expanders**—Bulletin 380, 8 pp, covers manufacturer's line of tube expanders for maintenance of high pressure boiler tubes, superheaters, economizers, circulating tubes, steam generators and t he equipment. Various models are illustrated by photo and described as to application. Thomas C. Wilson, Inc.

230 **Bent Tube Boiler Data**—This 20-pp book et is filled with engineering drawings of recent installation of company's Class VL boilers, designed for adaptation to limited space conditions in plants having diverse steam requirements. Text covers main design features of these bent tube boilers. Henry Vogt Machine Co.

231 **Steam Generators**—Engineering data on manufacturer's coal, oil, gas or combination fired package units for generating steam up to 35,000 lb per hour is presented in Bulletin PG-49-13, 12 pp. Includes dimensional data and drawings, a discussion of design features and drawings illustrating firing arrangements. Foster Wheeler Corp.

HEATERS, HEATING

232 **Tubular Heat Exchangers**—Bulletin 916, 32 pp., describes present designs of the company's tubular heaters, coolers, condensers and heat exchangers and their distinctive features. The various types of shells, tube bundles, stationary heads and floating heads are explained. An additional helpful feature are tables of the characteristics of tubing, the thermal resistance of tubes and pipes of many different metals and alloys, and the specific gravity and pounds per gallon corresponding to degrees Baume and API. Also presented are charts of specific heats of midcontinent crude oils and for solving MTD formula with correction factors for other than countercurrent conditions. The Griscom-Russell Co.

233 **Water Heaters**—Illustrated 6-pp Bulletin 70, Section I, on instantaneous type water heaters contains detailed capacity and dimension tables for two-pass, four-pass and six-pass designs, with tube bundles removable for inspection. A typical piping hook-up for installation of these heaters is shown. Also included are instructions for heater selection, engineering data to determine boiler capacities required for heating water, and a chart to determine pipe sizes for any steam flow at most pressures. Davis Engineering Corp.

234 **Combustion Catalysts**—Bulletin 36, 4 pp, explains the action of company's combustion catalysts, including one type developed for use in coal-fired furnaces and another for use in oil-fired furnaces. Tells how they help to remove soot, control smoke and alleviate the slagging problem in boiler furnaces. Also describes a simple hopper-type feeding device available for spraying the catalyst into coal-fired furnaces. National Aluminate Corp.

235 **Heating Unit**—This bulletin presents advantages of company's gas- or oil-fired self-contained industrial heating unit, explaining its operation, simplicity of installation, and describing and illustrating some of its applications. Includes specifications. Also contains engineering data to help analyse industrial heating problems, including procedures to determine heat load, fuel consumption. Thermobloc Div., Prat-Daniel Corp.

WATER TREATING, CORROSION PREVENTING

236 **Water Conditioning Bulletin**—This is an 8-pp discussion of water and the chemicals developed for conditioning it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition and application. Also discusses special purpose chemicals. Wright Chemical Corp.

237 **Boiler Water Manual**—Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-pp technical bulletin, called Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater system. Also discusses condensate returns, flushing periods, condenser cooling water treatment and chemical tanks. Proportioneers, Inc.

238 **Water Softener Equipment**—How the problems caused by hard water can be offset by the use of water softeners is explained in Bulletin 2386, 12 pp, describing ion exchange equipment. It covers in detail downflow, upflow and gravity zeolite water softeners. Contains a 2-pp cutaway illustration of a fully automatic softener to show how an ion exchanger is built and how it works. Bulletin also contains flow diagrams showing arrangements for installation of water softeners. The Permutit Co.

239 **Anti-Foam Treatment** — This 4-pp bulletin covers a new formula in powder form to be applied along with anti-scale treatment for improving steam quality, controlling scale in boiler feed system and sludge conditioning. It discusses the problem of steam contamination and explains the action of this polyamide anti-foam treatment. Tells how it should be applied and gives dosage requirements. A discussion of its advantages is accompanied by photos showing the effect of polyamide action on a boiling dilute Nacconol solution. Dearborn Chemical Co.

240 **Boiler Corrosion** — A 12-pp article discussing the cause and prevention of corrosion in boiler systems is presented in Betz Technical Paper No. 111 titled "Corrosion: Its Effect in Boiler Systems." The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity and physical factors are evaluated. Numerous illustrations, graphs and tables included. W. H. & L. D. Betz.

241 **Turbine Blade Deposit Study**—Identification and prevention of steam turbine blade deposits and boiler water conditioning to prevent such deposits are discussed in the new 16-pp illustrated Bulletin 28B7030. Describes x-ray diffraction methods employed by the company for identification purposes and the results obtained. Tables list the partial chemical analyses of deposits containing sodium disilicate, occurrence data on compounds found, composition of turbine deposits from turbines operating at various throttle pressures and temperatures, and comparison of compounds found in turbine blade deposits with boiler operating pressures. Allis-Chalmers Mfg. Co.

242 **Two-Stage Water Conditioner**—Bulletin 4801 describes company's water conditioner which combines the advantages of both hot process and zeolite softening. Explains operation of softener in which the first stage is the hot process using lime or Dolomitic lime and the second stage in which zeolite softener reduces hardness to zero. Discusses advantages of the combination—silica reduction, low alkalinities, lower CO_2 in steam, lower costs and tells applications to high pressure boiler plants. Cochrane Corp.

243 **Corrosion Treatment**—"Corrosion Protection of Steam and Condensate Return Systems" is a 4-pp folder covering amine treatment for inhibiting of boiler and condensate systems. This treatment is described as affording surface protection of the metal itself as well as raising the pH value of the condensate. Booklet gives specific case histories and typical economies obtained by power plants using this treatment. Includes graphs showing relationship between free CO_2, pH and alkalinity in water, and the solubility of oxygen in water when exposed to air at various pressures. The Bird-Archer Co.

244 **Chemical Feed Systems**—Single, complete "packaged" units for feeding directly into boiler feed water lines are the subject of 4-pp Bulletin 4811. It discusses in detail sodium sulfite feeding, internal treatment, chemical feeding, manual control, intermittent feeding of internal treating chemicals; automatic feed systems; automatic pH control, and automatic control by conductivity. Illustrations include photos and diagrams of controlled volume pumps. Milton Roy Co.

245 **Modern pH and Chlorine Control**—This 100-pp booklet is much more than a catalog, although it does give full technical details of all the color comparators and equipment in water testing and control of boiler and industrial process water manufactured by this company. Its most important feature is inclusion of technical information on the meaning of pH control, electrometric and colorimetric methods of determining pH and also determining constituent impurities in water; applications of water control in air conditioning; treatment of boiler feed water and industrial water, and other industrial applications. Color comparators are detailed and illustrated. W. A. Taylor & Co.

246 **Water Softeners**—Bulletins WC-102 is a 36-pp presentation of recent developments in hot-process water softeners. Explains boiler plant troubles caused by various impurities in water, outlines 12 methods of treating water to eliminate these impurities, describes reasons for the popularity of the hot-process method and its advantages, and explains the chemistry of hot-process water softening. The two basic designs and operation of company's hot process softeners are described, together with six adaptations of each design to various plant conditions, such as per cent make-up, treatment of condensate, deaeration. Methods of supplementary hot phosphate treatment are also discussed. Includes diagrams of hot process designs and flow charts, photos of installations. Graver Water Conditioning Co.

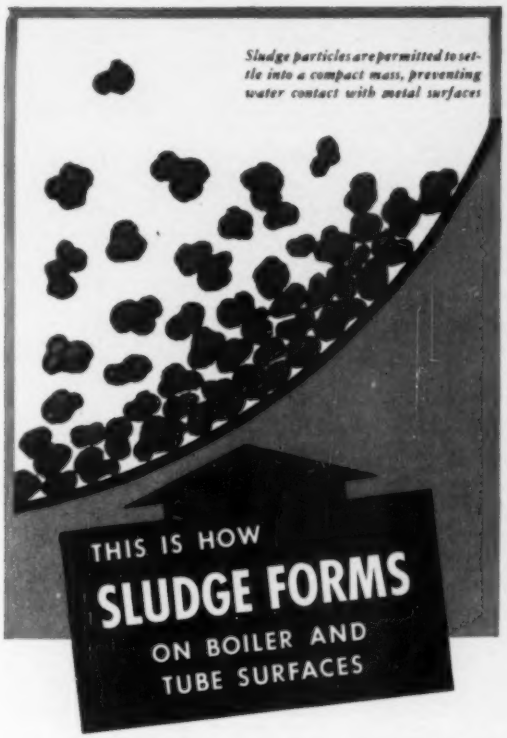
247 **Boiler Water Treatment**—Bulletin 47, 8 pp, is on internal treatment of boiler water. Defines internal treatment and tells its advantages in softening, sludge conditioning, stabilization. Explains operation of company's system, including the chemicals used, feeding and testing equipment. National Aluminate Corp.

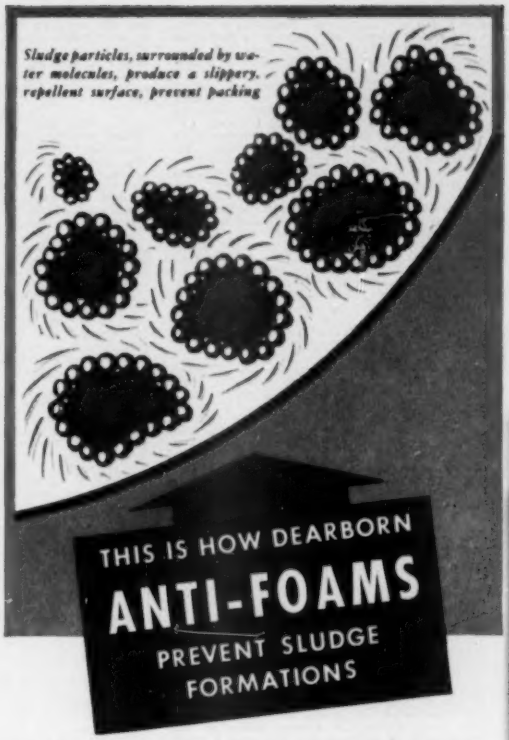
248 **Plant Wide Water Service**—Titled, "Let's Consider Your Whole Water Problem," this 4-pp booklet analyses water problems from four standpoints—procurement, treatment, usage and disposal—and explains how company is pepared to offer technical service in solving problems related to all four. Hall Laboratories, Inc.

249 **Water Hardness Test**—This technical bulletin presents a test procedure for determining hardness of water, by use of a color indicator which is described as both easy and accurate. Instructions for running the test are illustrated in color. Includes prices of company's complete hardness titration set and individual solutions used. W. H. & L. D. Betz.

PUMPS, COMPRESSORS, ENGINES

250 **Centrifugal, Reciprocating Pumps**—This is a helpful collection of bulletins covering many types of centrifugal and reciprocating pumps for a wide range of services. Includes data on single-stage and multi-stage pumps, close-coupled pumps, high pressure pumps, pumps especially suited for handling erosive and corrosive liquids and others. Contains photos, dimensions, specifications, ratings and application information. Warren Steam Pump Co., Inc.


Sludge particles are permitted to settle into a compact mass, preventing water contact with metal surfaces
THIS IS HOW
SLUDGE FORMS
ON BOILER AND TUBE SURFACES


Sludge particles, surrounded by water molecules, produce a slippery, repellent surface, prevent packing
THIS IS HOW DEARBORN
ANTI-FOAMS
PREVENT SLUDGE FORMATIONS

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3. As an Anti-Foam treatment, No. 659 reduces the number of small bubbles responsible for foaming conditions. Instead, it produces a relatively small number of large bubbles which break harmlessly on the surface.
4. Anti-Foam No. 659 prevents corrosion in feed lines, heaters and internal boiler surfaces caused by dissolved oxygen.

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251 **For Many Pumping Jobs**—The Series A313A, latest of company's well-known IMO pumps and especially designed for low cost standardized quantity production, is described in illustrated Bulletin L313A-B, 8 pp. This is a general service screw-type rotary pump for petroleum products and other light or viscous fluids as required for rotary and steam atomizing oil burners, oil transfer, lubrication, hydraulic systems and similar services. Bulletins contain a cross-section drawing, description of the IMO pumping principle, viscosity tables and motor frame sizes. De Laval Steam Turbine Co.

252 **Compressor Selection Chart**—Here's a new selection chart, based on normal applications handling air with atmospheric intake pressure. It simplifies selection of proper size compressor for average industrial use, with quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute and shows recommended compressor bore and stroke in inches. Chart covers two letter-size pages. Worthington Pump and Machinery Corp.

253 **Air Compressor Lubrication Manual**—Valuable information on air compressor maintenance is contained in this 40-page book on the lubrication of air compressors, second edition. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements, operating hints, oil requirements, storage and care of compressor oils, and safety precautions. All discussions are illustrated. Cities Service Oil Co. (In the South, Akansas Fuel Oil Co.)

254 **Modern Steam Engines**—In presenting steam engines as more than "just drives," Bulletin 308 touches briefly upon some of the advantages of "by-product" power. Bulletin features company's vertical steam engines of both thottling and automatic governor types. Sectional drawings are accompanied by engineering data, an illustrated discussion of construction features and photos of installations. Troy Engine & Machine Co.

255 **Pump Packings**—Packings for use on reciprocating and centrifugal pumps are illustrated by photo and described in this 4-pp folder. It covers packings for practically all services and includes a table of recommendations to facilitate selecting the right packing for any particular application. Johns-Manville.

TURBINES

256 **Turbine Catalog Collection**—This is a valuable collection of bulletins in loose-leaf form. They cover a complete description of manufacturer's solid wheel turbines and feature cross section drawings of typical units for both moderate and high steam pressure conditions. Also provides a description of an axial flow impulse, both single and multi-stage, and complete data on speed increasing and speed reduction gears. The Terry Steam Turbine Co.

257 **Velocity Stage Turbines**—Catalog 52-19R, 8 pp, features turbines for mechanical drives designed to operate under all inlet steam conditions up to 600 psig and 750 F. Gives complete specifications, dimensions and includes chart showing how to estimate turbine sizes. Illustrations include cutaway view, photos of parts. Speed governor and regulating valve, and emergency governor and trip valve are described. De Laval Steam Turbine Co.

FUELS, LUBRICANTS

258 **Steam Power Plant Auxiliaries**—In Vol. 26, No. 4, of Lubrication, a technical publication on selection and use of lubricants, is an article on recommended lubrication practices for steam power plant auxiliaries. Illustrated with photos and sketches, it discusses automatic coal firing machinery, stoker design, pulverizers, tube cleaners, compressors, motors, fans and blowers, external reciprocating elements of pumps and compressors. The Texas Co.

259 **Diesels, Their Fuels and Lubricants**—This 46-pp book offers a well organized and attractive presentation of practical information on diesel engines, covering their history and economics as well as discussing their design characteristics and operating principles. Classification of diesels according to speed is explained. Other chapters cover injection systems, combustion chambers, lubricating systems, and diesel oil purification and filtration. The balance of the book is devoted to a discussion of fuel and lubricating oil required by diesels and description of company's products. Book is filled with photos, sectional illustrations and schematic drawings; includes table showing relation of engine performance characteristics to fuel properties. Sinclair Refining Co.

260 **Fuel Oil Treatment**—By text and sketches, this folder points out undesirable conditions in the storing, pumping, heating and burning of industrial fuel oil and the correction of these conditions by company's fuel oil treatment. Defines sludge and includes instructions for application of the fuel oil treatment. E. F. Drew & Co., Inc.

261 **The Answers on Turbine Oil**—This 2-pp booklet answers several questions power engineers ask about turbine oils, including: What causes deposits of sludge? What causes acidity increase? What causes corrosion in turbines? Explanations are brief but thorough. Booklet is illustrated with photos of turbine installations in which manufacturer's products have been used successfully. Standard Oil Co. (Indiana).

COAL HANDLING

262 **Coal Scale Data Book**—The answers to a power engineer's questions on coal scales are provided in this excellent 48-pp book, Bulletin 1143, covering scales for recording weight of coal consumed by individual boilers and weight of coal receipts from ship, car, truck or storage. It is generously illustrated with photographs of models and accessories and actual plant installations and contains all necessary engineering drawings, dimensional data and detailed specifications. Construction features and operation of weighing and feeding systems are described. Richardson Scale Co.

263 **Spreader Stokers**—Catalog 80, 44 pp, describes a spreader stoker with forward moving grate that slowly and continuously discharges ash at the front. Explains the efficiency and economy of this stoker, illustrating grate's design and operation. Includes discussion of typical power plant installations of these stokers, covering more than 30 industrial, institutional, municipal and public utility installations through the country. These are illustrated by photos and blueprint drawings. Detroit Stoker Co.

264 **Coal Handling Equipment**—Modern equipment for the storage and handling of coal and ash is presented in 24-pp Bulletin 300. Illustrated with sketches and photos of actual installations, it covers concrete and tile silos, cylindrical steel tanks, and suspended steel bunkers with gravity discharge bucket elevators and pivoted bucket carriers. Gifford-Wood Co.

265 **Spreader Stoker**—Bulletin SB 31, 4 pp, explains and illustrates, by photos, the design and construction features of company's spreader stokers, stressing their advantages. Also contains photos of installations. Erie City Iron Works.

266 **Small Crushers**—"For Better Testing and Small Scale Reduction" is the title of this 6-pp bulletin describing in detail the many practical applications of company's small crushers, grinders, and shredders for reduction of coal, by-products, chemicals, clays and many other products. Typical installations are clearly diagrammed and explained. Special attention is devoted to construction features and functional advantages of the different mills as applied to various reduction jobs. American Pulverizer Co.

267 **Spreader Stoker Selection**—Fourteen-pp Form P-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered in the selection. It pictures and describes in detail the principle operating parts of manufacturer's stokers, emphasizing their advantages. Includes engineering drawings and photos of typical installations. American Engineering Co.

DUST COLLECTING

268 **Fly Ash Elimination**—Power engineers will find this 30-pp booklet outstanding among material on this subject. It presents manufacturer's "Multiclone" equipment (described as small-tube type of cyclonic dust collectors using centrifugal force for separating dust from gas stream) as a highly successful and economical means of separating fly ash—not as a panacea for all cinder and fly ash problems. Parts and assemblies are illustrated by photos and drawings and explained in terms of construction, operation and capacities. Particle size and its significance in fly ash elimination, is discussed and so is dust collecting efficiency as affected by operating conditions. Book also contains engineering data on single and double hopper installations. Western Precipitation Corp.

269 **Dust Collectors**—Dust collecting equipment for power plants, foundries, cement plants and similar industries is the subject of Bulletin No. 1428, 28 pp. Contains many photographs of installations, also photos showing equipment being tested in company laboratories. Discusses services offered by manufacturer in analyzing individual installation requirements. American Blower Corp.

270 **Dust Collecting Efficiency**—How the higher and narrower inlet utilized in company's tubular dust collector contributes to more efficient dust collecting is explained in this illustrated bulletin. Cutaway drawings showing tube design and micron efficiency curves accompany the text. Prat-Daniel Corp.

METALS

271 **Steels for Hot Spots**—This is an 88-pp manual filled with information on steels for elevated temperature service. Includes a discussion of the general principles of high temperature behaviour of ferrous materials and the factors influencing their behavior; a data section replete with tabular and graphical material covering mechanical property values of 21 steels; and illustrated description of major high temperature testing facilities in the United States, and a comprehensive bibliography of company's technical publications on the properties and use of steel at high temperatures. United States Steel.

272 **Corrosion Resistance of Nickel Alloys**—Technical Bulletin T-3 contains 44-pp of illustrated information on the resistance of high nickel alloys to corrosion by sulfuric acid. Although technical in nature, it is written so as to be readily understood by non-technical staffs. Performance of 30 nickel-bearing materials in a wide range of service is discussed, and there are 26 tables and 33 graphs and photos. Problems involving a wide range of operations are covered. The International Nickel Co., Inc.

MECHANICAL POWER TRANSMISSION

273 **Transmission Belting**—Catalog M-9922, 28 pp, gives detailed design, engineering and performance data on manufacturer's line of transmission belting. Tables on belt speeds, arc of contact, friction, horsepower correction, and service factors are included in the manual, together with hints on proper selection of a belt and procedure for analyzing belt drives. Illustrations include many photos of belt installations and drawings of transmission drives. United States Rubber Co.

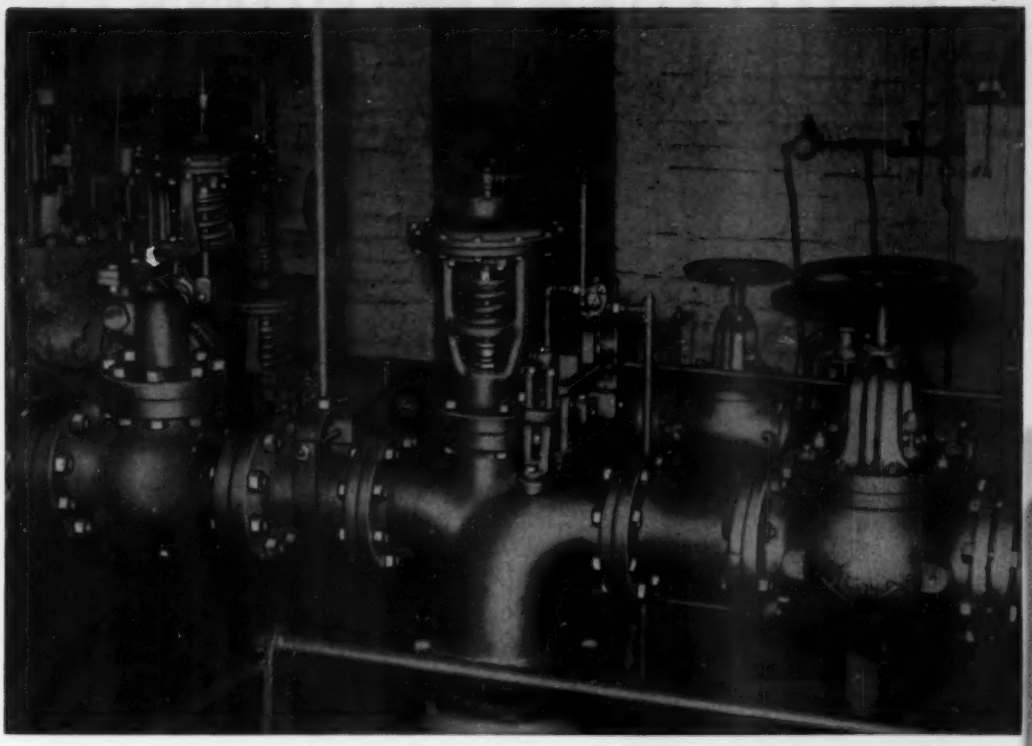
274 **Traffic Cops for Speed Drives**—Book 2349, 8 pp, introduces a new line of automatic speed controls for use with company's PIV variable speed drive, which are designed to automatically control output speed range. Describes and illustrates the four available types—electronic, pneumatic, hydraulic and mechanical. Includes diagrams of job engineered applications covering some of the many industrial uses for these controls. Link-Belt Co.

OTHER EQUIPMENT

275 **Condensers**—Bulletin 441-C, 28-pp, covers in detail every phase of manufacturer's line of condensers—their simplicity of design, accessibility, construction features. Illustrated with photos and drawings showing complete assemblies, parts, principles of operation. Bulletin also discusses emergency replacements, service and maintenance facilities available, and auxiliary equipment. Includes condenser tube data, pressure-conversion tables. Condenser Service & Engineering Co.

276 **Concrete Floors Q & A**—The detailed information contained in this booklet brings up to date, the service experiences and late developments in this field. The information covers methods and materials used in placing corrosion resistant concrete in a wide variety of industrial applications. Typical uses of corro-

(Continued on page 132)



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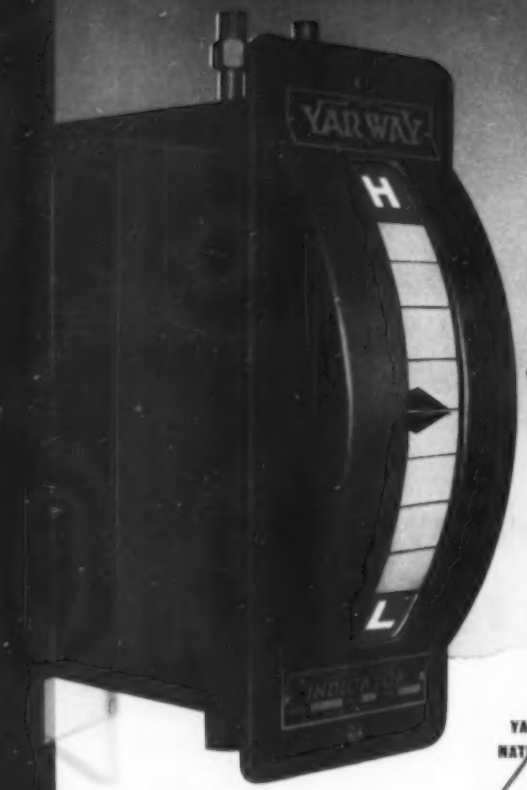

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Now you can have constant check-up on water levels wherever —and whenever—you want.

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Three Yarway Remote Hi-Lo-Alarm Signal Lights, showing low level, normal operation and high level. Each unit shows all levels.

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LETTERS TO THE EDITORS

MR. ROSENSTEIN, PLEASE NOTE

I AM VERY grateful to you for having smoked out one of the scalawags who mis-design plants. In a long life I have never been able to pin one of the slippery malefactors down, but this man Rosenstein seems like a square-shooting, fearless individual; he steps right up for the profession and says "I did it with my little pencil."

When a culprit pleads guilty, my vengeful feelings toward him evaporate and I am filled with compassion and a desire to forgive; however in the case of a plant designer, who puts valves in inaccessible places, takes them out, moves them around and finally winds up by putting them back in the original tough spot, this feeling of forgiveness is accompanied by a fervent hope that his last move in this game of who's got the button will be to leave them out—or place them in the general location of his soft foam rubber pad.

I believe, now, draftsmen have a tough life, moving valves and heavy pieces of machinery here and there and the din and confusion caused by checkers, purchasers, project engineers, etc., makes it difficult for them to do much straight thinking. I often wondered what interfered with this process. I have seen designers on the verge of a nervous breakdown, through worrying about the difficulties of the operating engineer. Occasionally I have seen designing engineers leave the drafting room and never come back, after having designed some expensive piece of equipment, that nobody could make work.

Once in a while a plant is born, with all valves and handling equipment within easy reach and I have never heard or read of any compaints about the flexibility of the piping systems or fluid flow being interfered with. It is possible that such plants are accidental; some wonderful inventions have been stumbled on just by accident.

I must leave now for First Aid to get a little lamp treatment on my shoulder, which I strained yesterday, trying to get my eager, trembling fingers on a valve that was plainly intended to be reached only by a Kamikaze.

Hopefully,

Plymouth, Mich. J. E. GLEASON,
Engineer
Evans Products Company

SYSTEM OPERATION ON THE PACIFIC COAST

I HAVE BEEN VERY much interested in recent descriptions of new, large generating stations in which all of the steam-driven auxiliaries, including emergency steam-driven boiler feed pumps, have been eliminated and where shaft-end generators are used to provide auxiliary power.

I am thoroughly familiar with the arguments in favor of the shaft-end generator. However, there have been a number of actual instances on Pacific coast power systems where a load suddenly thrown on a steam power plant has reduced the frequency to a point where the motors driving auxiliaries tripped out, resulting in their loss at the very time when they were needed most. It was for this reason that house turbine generators were installed at the Harbor Steam Plant of the Los Angeles Department of Water and Power, and also in the new steam plants of the Pacific Gas & Electric Co. At the Harbor Steam Plant, after an experience of the kind referred to above occurred, previous to the installation of Unit No. 1 house generator, an emergency steam turbine driven fuel oil service pump was installed.

The reason for the tendency in eastern stations to eliminate all steam-driven auxiliaries probably is due to the fact that the Eastern systems are more integrated than the western power systems, and therefore power for emergency operation of auxiliaries is practically always available from other stations on the system and over transmission lines that are not too long.

This question brings to mind an experience, back in 1921, when I was employed as an operator at the old Bay Shore substation of the Sierra & San Francisco Power Co., now a part of the P.G. & E. system. The arrangement of this system was roughly as shown in Fig. 1. The actual location of the stations are shown on the map, Fig. 2.

The North Beach Steam Plant contained three 9000 kw turbo-generators. The strut railway load of San Francisco was supplied by the North Beach and Stanislaus plants. One generator at Kerchoff was available when required.

The auxiliary set up at North Beach was very unusual. Originally, all auxiliaries were steam driven, the exhaust being used in open feedwater heaters. On light loads, excess auxiliary exhaust was fed into the low pressure stages of the main turbines. As this proved unsatisfactory, some motor driven auxiliaries were installed. The house transformer bank lacked capacity to feed the additional motors. The Pacific Gas & Electric Co. had a distributing substation in one end of the turbine room, so the new motor driven auxiliaries were supplied from this substation, which was a completely outside source of power. This meant that trouble on the Sierra system would not affect the motor driven auxiliaries, while trouble on the P.G. & E. system would cause the

(Continued on page 126)

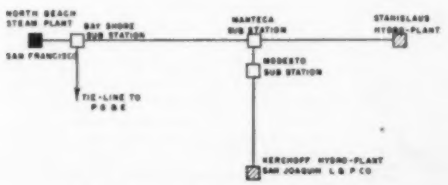

NORTH BEACH STEAM PLANT
BAY SHORE SUB STATION
SAN FRANCISCO
MANTECA SUB STATION
STANISLAUS HYDRO PLANT
MODESTO SUB STATION
TIE-LINE TO P G & E
KERCHOFF HYDRO-PLANT SAN JOAQUIN L & P CO

Fig. 1. Schematic arrangement of the system

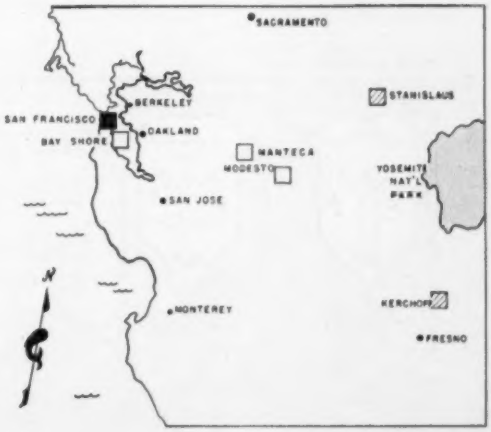


Fig. 2. Map showing location of the station involved

A POWER ENGINEERING FEATURE

Hot Zeolite Softening

A modern method of boiler feedwater treatment that provides a low-cost, convenient solution to some serious present-day boiler plant operating problems. This article describes its development and compares its effectiveness with the conventional two-stage hot process precipitation process

By V. J. CALISE
Technical Director, Graver Water Conditioning Company, New York, N. Y.

THE DEVELOPMENT and use of styrene-base resin zeolite softeners as second-stage treatment following first-stage hot process precipitation softeners is of interest to both power engineers and feedwater consultants, since this method of treatment in certain cases offers specific advantages over the usual two-stage hot process softeners using lime and soda ash in the first stage and phosphate in the second stage.

Hot Process Precipitation Treatment

Recent development of new methods using the ion exchange principle has brought the cost for demineralizing and silica removal down to a range where these methods compete with the 2-stage hot process treatment on lower solids waters, yet there are many intermediate pressure applications where such high purity water is not required, and in such cases, the 2-stage hot process treatment, because of its lower initial cost, its greater flexibility or lower operating cost, is of advantage.

Since the early years of this century when hot process equipment was first developed and applied, this method of treatment has enjoyed increasing popularity and use. During the years the hot process softener has undergone progressive development so that now it can handle many different types of feedwaters, all within the confines of one or two vessels in series plus certain accessory equipment.

The hot process method has a number of advantages over cold process precipitation or zeolite systems, as follows: 1—Dissolved hardness in water can be reduced to any desired value, cheaply and easily. 2—Silica can be reduced to any desired value below 0.5 ppm at very lowest cost. 3—Cost of chemicals such as lime and soda ash is low, first because the cost in cents per pound is low, and second, the quantities needed are usually not large. 4—Gaseous impurities and deaeration of treated water to concentrations of less than 0.005 ml per liter of oxygen together with as much as ten minute storage of deaerated water can be combined in a single vessel at relatively slight additional cost compared with separate deaerator and storage equipment. 5—Moderately turbid waters can be clarified, in some cases without pretreatment, simultaneously with softening, silica removal, and deaeration. 6—The use of deep sludge beds and/or sludge recirculation effects the removal of many organic impurities. 7—Waste heat is recovered in the use of exhaust steam. 8—Labor required for attendance is low and the quality of the water obtained is uniform for water supplies having constant or slowly-changing composition. 9—Non-corrosive water of high pH value is obtained. 10—Finally, since hot filter backwash water is recovered, the amount of waste water resulting from the hot process precipitation system is very small. Table I shows typical results, treatment costs and other boiler plant design factors for several single- and two-stage hot process precipitation installations in operation for a number of years on various water supplies.

Second-stage Hot Zeolite Softening

The increasing use of boiler pressures ranging from 450 to 1200 psi, coupled with high heat absorptions, is placing an increasingly heavier burden on the feedwater treating equipment. To avoid costly outages, feedwater of greater and greater purity is required. Concentrations of impurities, such as Ca^{++}, Mg^{++}, SiO_2, CO_3^{--} alkalinity, pH values, etc., in treated water from 2-stage hot precipitation systems which formerly were satisfactory for lower pressures and boiler ratings, are now no longer suitable for trouble-free operation in some cases.

Since it is desirable in modern high pressure plants to keep the percentage of makeup low and to conserve the relatively pure condensate, the condensate return systems used are often elaborate and expensive to install and maintain. If high amounts of CO_2 are evolved in the boiler, the condensate in the steel

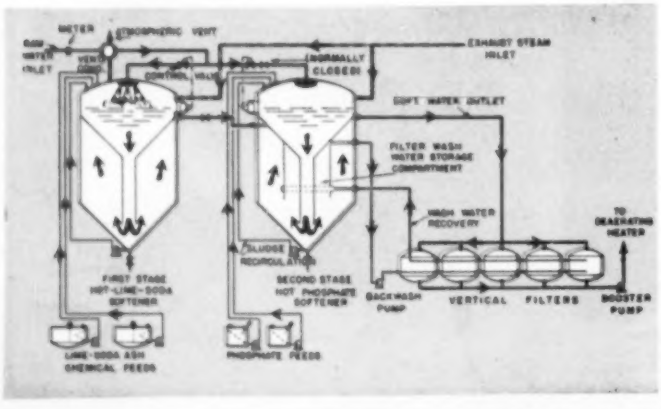


Fig. 1. Diagram of a 68,000 gph 2-stage hot-process softener at a Gulf Coast Refinery. Boiler pressure, 650 psig at 650 F. Total steam evaporation, 600,000 lb per hr

return lines will have low pH, and corrosion may result.

In industrial plants, in order to conserve water, it is often necessary to use several different sources of raw water such as wells and various kinds of river and lake water. This complicates the problem for the designer who must provide chemical feeding systems that are accurate, precise and easily adjustable with change-over in water source and composition. This problem is particularly important where the quality of the water from the 2nd-stage phosphate unit depends largely upon the proper chemical dosing in and the quality of the effluent from the first stage unit.

The cost of skilled labor for proper operation where variable water supplies are involved is a factor of concern to the power plant engineer, as is also the high cost of phosphate where a high percentage of makeup is needed. Economy of operation also affects the design of and maintenance of economizers where the 2-stage hot process system of treatment is used. When economizers foul up frequently maintenance costs run high.

These conditions in modern high pressure plants impose certain limitations on the use of treated feedwater from the 2-stage hot process precipitation softener. Table I shows the range of total hardness, and alkalinities obtainable from 2nd-stage and single-stage hot precipitation systems using lime, soda ash, and phosphate compounds. Operating experiences of these and other plants show that solubility product relationships with these treatment processes require excesses of approximately 25 ppm soda ash as $CaCO_3$ in the 1st-stage for optimum hardness reduction to less than 1 gr per gal as $CaCO_3$. Also 5-8 ppm excess PO_4^{---} as $CaCO_3$ at a high pH of 10.2 to 11 together with carbonate alkalinity of 45 to 60 ppm are required in the 2nd-stage unit to reduce the total hardness below 2 ppm as $CaCO_3$. Furthermore, operation of such hot process equipment frequently results in concentrations of Mg^{++} of greater than 0.2 ppm and as high as 1 ppm in the effluent, since the magnesium is usually 30 to 40 per cent of the total hardness as $CaCO_3$.

Magnesium Phosphate Sludge

Operation experience in a number of modern boiler plants has shown that the two-stage lime-soda-phosphate hot process precipitation system of treatment is not always satisfactory for trouble-free operation.

For example, in the high makeup plants with high pressures and ratings and particularly those with variable water supplies, it has been found that concentrations of magnesium, Mg^{++}, above 0.2 to 0.4 ppm as $CaCO_3$, together with PO_4^{---} concentrations greater than 5 ppm as $CaCO_3$ as normally obtained in the effluent from 2-stage hot precipitation units, after concentration 15 to 25 times in the boiler salines, results in the formation of sticky magnesium phosphate sludges in areas of restricted circulation, causing tube failures. Close adjustments of chemical feeds for uniform effluent hardness together with tight internal treatment control is required at present to avoid this difficulty.

Higher Average Total Hardness on Variable Raw Waters

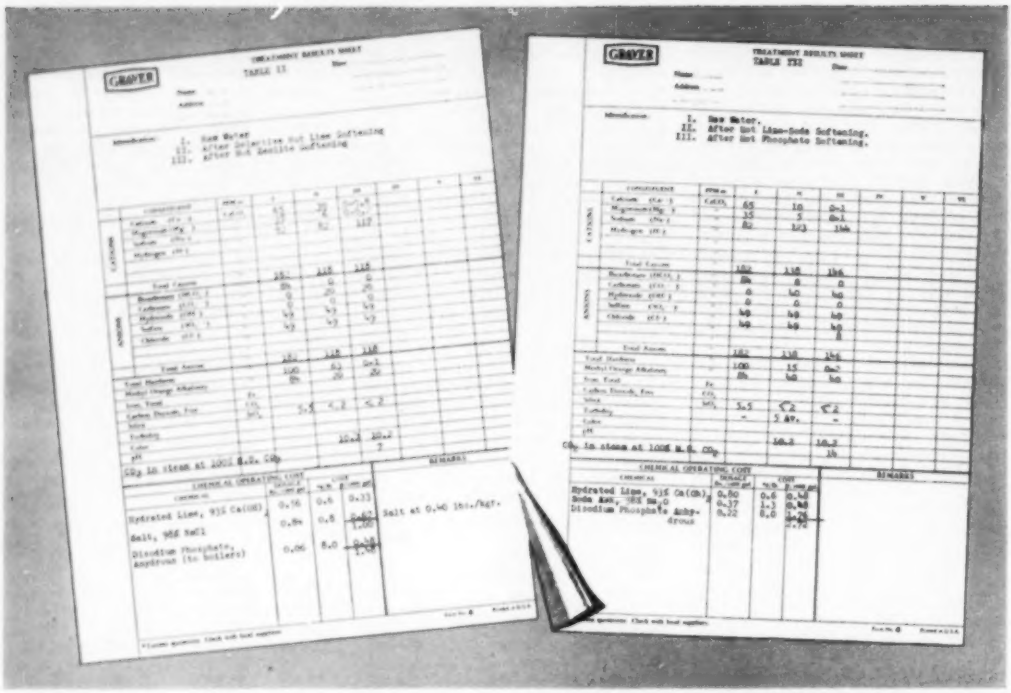
In many cases with variable raw waters, the concentration of total hardness in the effluent and completeness of treatment from the 1st-stage unit varies and, therefore, the effluent from the 2nd-stage phosphate unit varies from 0.5 up to 2 or 3 ppm in hardness depending upon variation in raw water composition and chemical feed adjustments. In some cases, this higher average hardness, together with phosphate concentrations of 5 or 6 ppm as $CaCO_3$ at a pH of >10, results in

Table I. Typical results from large Graver 2-stage or single-stage hot process precipitation softening installations

PLANT		A	B	C	D	E
Location		Gulf Coast Refinery	Midwest Refinery	Midwest Chemical	Northern Utility	Eastern Steel Mill
Source of Supply		Well	Lake	Lake	River	Well
Outlet Capacity, lb./hr.		600,000	1,000,000	575,000	1,225,000	1,000,000
Boiler Pressure, psig		650	900	750	625	250
Makeup, % of Total Evap.		90-100	90-100	95-100	95-100	95-100
Single Stage		—	—	—	Yes	Yes
Two-Stage with Phosphate		Yes	Yes	Yes	—	—
Sludge Bed, Aver. % by Wt.		4-8	3-7	6-8	—	—
Sludge Recirculation, % of Influent Flow		3	3-5	—	5-7	—
Graver Type Softener Design		SW	F	S, F	F	F W
Deaerator Design		External Spray Type	External Tray Type	Internal Spray Type	Internal Spray Type	Internal Spray Type
Aver. Chem. Fed, Lbs./M Gals.	Hyd. Lime 97%	—	1.1	0.81	2.1	0.28
	Dol.Lime32%MgO	1.9	—	—	—	—
	Soda Ash 98%	0.12	0.16	0.56	0.83	1.1
	Disod. Phos, Anhydrous	0.21	0.25	0.18	—	—
Aver. Chem. Operating Cost, ¢/M gals.		3.1	2.8	2.6	2.3	1.4
Carbon Dioxide in Steam, ppm as CO_2		24	13	14	12	18

INFLUENT AND EFFLUENT COMPOSITION

	CATIONS—ppm as $CaCO_3$				ANIONS—ppm as $CaCO_3$							OTHER CONSTITUENTS			
	Ca^{++}	Mg^{++}	Na^{+}	Total	HCO_3^-	CO_3^-	OH^-	SO_4^-	Cl^-	PO_4^{---}	Total	ppm as SiO_2	ppm Turbidity	ppm Color	pH
Plant A															
Raw Well Water	77	41	78	196	148	0	0	21	27	0	196	45	—	—	10.2
Treated Water	0-1	0-1	112	114	0	60	0	21	27	6	114	2	—	—	7.3
Plant B															
Raw Lake Water	85	35	75	196	130	0	0	50	15	0	195	3-4	10-40	10-20	7.0
Treated Water	0-1	0-1	131	133	0	45	15	50	15	8	133	1-2	—	—	10.4
Plant C															
Raw Lake Water	102	28	39	169	94	0	0	35	40	0	169	—	30	—	7.9
Treated Water	0-1	0-1	122	124	0	43	0	35	40	6	124	—	—	—	10.3
Plant D															
Raw River Water	177	102	21	300	213	0	0	68	19	—	300	6.8	40-900	—	6.8
Treated Water	12	5	130	147	0	43	17	68	19	—	147	2-4	—	—	10.6
Plant E															
Raw Water	65	34	270	369	9	0	0	330	30	—	369	—	—	—	6.3
Treated Water	10	7	407	424	0	50	14	330	30	—	424	—	—	—	10.6



Tables II and III. Comparative performance of hot zeolite softening and hot process precipitation softening

economizer fouling unless acid is fed to reduce pH and keep the phosphate salts in soluble form. Also, the job of keeping internal boiler saline precipitates from adhering to tube surfaces becomes more difficult with the higher average hardness and the non-uniform alkalinity concentration. Higher effluent hardness from the 1st-stage treatment in such cases also requires higher amounts of expensive phosphate compounds in 2nd-stage treatment or in the boilers.

Higher CO_2 in Steam

The high cost of phosphate compounds used in the 2nd-stage unit requires reduction of hardness to the very lowest concentrations possible in the 1st-stage unit. Soda ash excesses of about 25 ppm are necessary, as shown in Fig. 2, to reduce total hardness below 17 ppm as $CaCO_3$. In the 2nd-stage unit, the soda ash excess is increased to 45 to 60 ppm by use of sodium phosphate compounds which react with the hardness compounds as shown in Table I.

In some plants, with the higher amounts of condensate returns, there may be sufficient CO_2 evolved from the decomposition of the 45 to 60 ppm of carbonate (CO_3^{--}) alkalinity in the 2nd-stage lime-soda phosphate treated effluent to promote excessive corrosion of condensate return lines and fittings. The excess carbonate alkalinity is present mainly as soda ash which is virtually 80-90 per cent decomposed in the boiler according to the following equation:

$$Na_2CO_3 + H_2O \rightleftharpoons^{\Delta} 2NaOH + CO_2$$

100 ppm as $CaCO_3$ — 44 ppm as CO_2

With 100 per cent makeup, about 18 to 24 ppm of CO_2 as CO_2 is formed in the steam and with 70 to 80 per cent makeup 13 to 18 ppm of CO_2 as CO_2 can be found in the steam.

This amount of CO_2 can result in the formation of corrosive condensate at a pH of 5 to 6. Good engineering practice, as determined with results from sodium-hydrogen zeolite or zeolite plus acid system usually limits the amount of CO_2 in steam to less than 8 ppm and preferably below 5 ppm as CO_2, to avoid such corrosion. Only where very low alkalinity, low hardness raw waters are encountered and acids such as sulfuric or phosphoric can be employed ahead of a single stage hot phosphate softener, is it possible to obtain an effluent of low hardness (less than 2 ppm total hardness as $CaCO_3$) together with low CO_3^{--} alkalinity with hot precipitation treatment.

High Cost of Phosphate Compounds

Phosphate compounds are among most expensive chemicals employed in water treatment. Disodium phosphate (anhydrous) costs approximately 7.5 cents per lb in larger quantities and approximately 0.15 lb per 1000 gal are required for reaction with 17 ppm of total hardness as $CaCO_3$ from the 1st-stage unit or approximately 1.125 cents per 1000 gals. This is relatively expensive chemical treatment.

Advantages of Hot Zeolite over Hot Phosphate for Second Stage Treatment

Against the above background of boiler plant operating experience and the limitations of hot process precipitation treatment and assuming a zeolite resistant to high temperatures above 212 F and high pH, above 10.2 could be obtained, it appeared clear that hot zeolite softening in 2nd-stage treatment had specific advantages over 2nd-stage phosphate as follows:

(a) A lower magnesium hardness of less than 0.2 ppm in the treated makeup feedwater can be obtained consistently regardless of raw water variations or 1st-stage chemical treatment by utilizing a resin zeolite which would be selective for magnesium. Furthermore, with low magnesium and low pH, phosphate scavenger treatment can be maintained at only 1 or 2 ppm in the feedwater and only 10 to 25 ppm PO_4^{--} in the boiler salines thus reducing the possibility of trouble due to magnesium phosphate scale.

(b) A lower total hardness can be obtained consistently regardless of raw water composition by properly

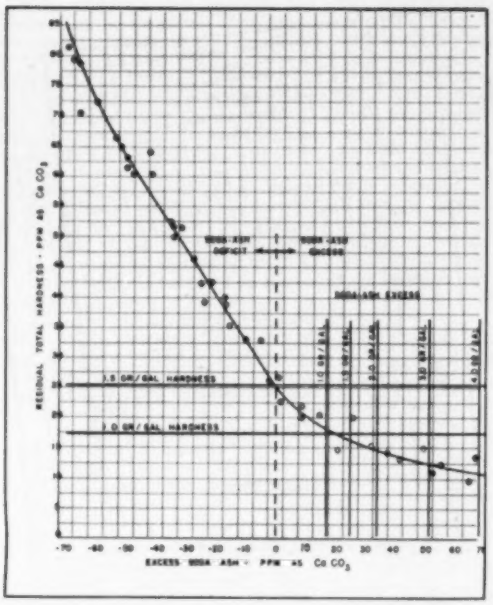


Fig. 2. Hot lime soda softener effluent curve showing residual hardness vs soda ash excess. Temperature 204-222 F. (Actual data from various plants operating on many different water supplies)

designing the resin zeolite softeners to give less than 1 ppm total hardness at all times. This reduces the dosage of phosphate required for scavenging treatment and also reduces the amount of scale formed in the boiler.

(c) A lower carbonate alkalinity (CO_3^{--}) in the 2nd-stage effluent can be obtained by eliminating the need for excess soda ash in the 1st-stage treatment and permitting higher concentrations of calcium, Ca^{++}, to depress the carbonate, CO_3^{--}, concentration to less than 20 ppm as $CaCO_3$ instead of 45 to 60 ppm as with the usual 2-stage treatment, as shown in Fig. 2. This reduces the possibility of corrosion in condensate return lines.

(d) A lower chemical treatment cost is obtainable by the use of inexpensive salt for zeolite regeneration at 0.25-0.40 cents per kgr of hardness (0.7-1.0 cents per lb for 98 per cent NaCl) rather than anhydrous disodium phosphate at approximately 1.1 cents per kgr of hardness. In many cases also, it is more economical to employ salt for regeneration of zeolite rather than soda ash for 1st-stage treatment.

(e) By reducing the magnesium and excess phosphate concentrations in the treated feedwater, there is no need for acid feeding to reduce pH to avoid deposits in economizers, preheaters, etc.

(f) Since lime is the only chemical required for 1st-stage treatment, lime feeding can be automatically adjusted relative to influent alkalinity or pH.

European Practices

Resin zeolite for 2nd-stage hot zeolite softening of hot lime-soda treated effluent had been used to some extent in Europe for several years before the last war. (Ref. 1) During the war, phenolic and naphthalene base resin zeolites were used in Germany for this purpose even though a high rate of deterioration was experienced due to the inherent instability of these resins at high pH and high temperatures. (Ref. 2) During the war, German boiler plants were operated at very high heat rates and with high overload conditions so that the importance of having a low hardness, low magnesium, low-silica influent such as obtained from hot lime-soda process —hot zeolite treatment was paramount, even at the expense of high operating cost. Experiments conducted in Germany and England indicated that the presence of oxygen in the hot alkaline influent to these resin zeolites appreciably increased degredation and, consequently, deaeration of the hot influent was practiced to reduce replacement losses. Nevertheless, high rates of replacement of these resins was a problem and resulted in very high operating costs.

American Practices and Laboratory Evaluations

In this country, it had been clearly established that the early greensand-type and synthetic siliceous zeolites could not be used on waters having temperatures above 95 F or pH above 8.3 without appreciable deterioration. The advent of phenolic resin-type or coal derivative-type zeolites permitted the softening of waters at slightly higher temperatures up to 140 F. Several installations of phenolic exchangers such as Gravex RL-30 and RF-20 were made in the years 1944 to 1947, operating on neutral clear waters having seasonal variations in temperature up to 130 F. No unusual difficulties were encountered as long as temperatures were maintained below 140 F at neutral pH values with clear, clean waters. Tests made at several installations indicated that quantities of oxygen in the raw water were absorbed by phenolic and coal derivative zeolites at high temperatures.

In December, 1945, the first styrene-base (so-called nuclear sulfonic) resin zeolite, Gravex RL-40 (Dowex 50 or Nalcite HCR) became commercially available. (Ref. 3) Laboratory and field pilot plant tests with this spherical bead product indicated the exceptional resistance of this product to high temperature and high pH. For example, boiling at 100 C in a solution of caustic soda at a pH of 11.0 for a period of some weeks in a setup, as shown in Fig. 3, revealed no breakdown as evidenced by before and after measurement of capacity, friability and crushing strength of the particles, resistance to oxidation or chlorination, and increased number of fractures of the spherical particles. This product also showed exceptionally high capacity and salt efficiency as indicated in Fig. 4. Laboratory and pilot plant field tests have also shown the importance of maintaining the styrene-

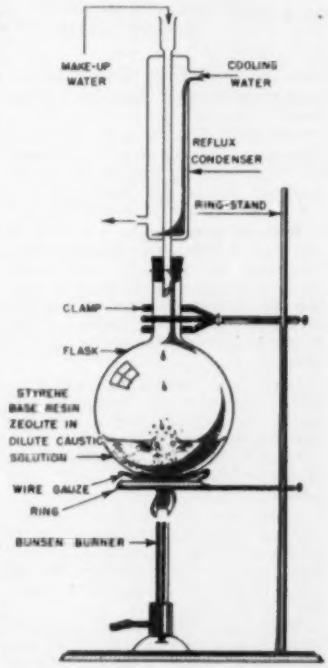


Fig. 3. Setup for high temperature, high pH resistance studies for styrene base resin zeolite

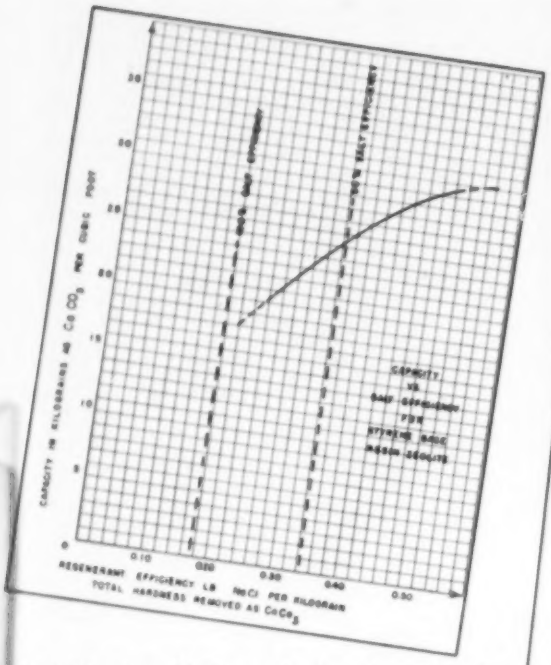


Fig. 4. Capacity vs Salt Efficiency for styrene base resin zeolite

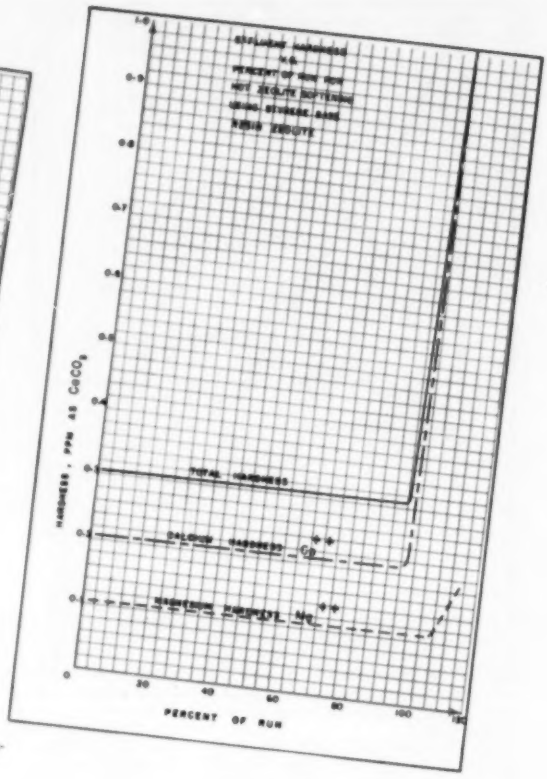


Fig. 5. Effluent hardness vs per cent of run for hot zeolite softening using styrene base resin zeolite

base resin free from thermal shocks to prevent fracture and fines formation.

Present indications are that changes in temperature occasioned by regeneration, rinsing or backwashing should not exceed 0.5 to 1.0 F per minute to avoid "shock."

Whereas free chlorine residuals in the raw water were quantitatively absorbed by phenolic and coal-derivative cation exchangers or zeolites, the styrene base resin permitted virtually 100 per cent passage of the chlorine without absorption or reaction.

Laboratory tests at high temperatures indicated that there was virtually no oxygen pickup by this styrene-base material and no decrease in density or increase in water holding capacity over long periods of time.

More recently, another styrene-base product has become available commercially having properties similar to the earlier Gravex RL-40. This product is Gravex RE-3 (Amberlite IR-120).

With these test results as background, several installations of styrene-base resin, Gravex RL-40, were made for softening hot water. One such installation was made at a flour mill processing plant in Memphis, Tennessee, early in 1947 where 456 cu ft of Gravex RL-40 was installed to replace 456 cu ft of Gravex RL-20, phenolic-base resin in three 96 in. diameter by 8 ft Graver zeolite softeners operating at 900 gpm on 3-4 gr per gal water saturated with oxygen and heated in heat exchanger jackets up to 170 or 180 F. The phenolic resin zeolite had shown preliminary signs of deterioration such as color-throwing, increased "fines" formation, increased water holding capacity, etc, after about six months of operation. The styrene-base zeolite has not indicated any operating difficulty up to the present time.

Based on the experience obtained at this and other installations operating at intermediate temperatures and pH values of 6 to 8.3, plus the long term, accelerated laboratory tests at high temperature and high pH, a number of small scale pilot plant hot zeolite units were installed operating on both the filtered and unfiltered effluent from actual large-scale, hot process softeners. The results from some of these plants have been reported in the literature. (Ref. 4, 5, and 6.) The pilot plant tests at an eastern steel mill and a southwestern refinery both employing Gravex RL-40 were studied closely by Graver engineers and chemists.

The influent to the hot zeolite units contained 10-20 ppm total hardness as $CaCO_3$ with methyl orange alkalinity of 40-60 ppm and phenolphthalein alkalinity of 20-35 ppm.

The results from these small-scale, hot zeolite installations can be summarized as follows at the present time:

A. Treating Filtered Effluent From 1st-Stage Hot Process Softeners

1. No breakdown in particle size, increased number of fractured spheres, softening of particles, increased water holding capacity or other evidence of physical deterioration after more than 1,200,000 gal per cu ft of resin have been softened at pH of 10-10.8 and temperatures varying between 212 and 230 F.

2. Slight drop in capacity from 26 to 22.5 kgr per cu ft is obtained at a salt dosage of 0.40-0.5 lb per kgr after a total of about 45 units regenerations over a period of about six months treating more than 1,000,000 gal of filtered effluent per cu ft of resin. This may have been due to some unavoidable changes in regeneration procedure reducing average salt concentration in contact with the resin.

3. Regardless of frequency of regeneration, backwashing of styrene-base resin at least once every 36 hr is required to assure low hardness leakage at all times.

4. At operating rates of less than 3.25 gpm per cu ft Gravex RL-40, styrene-base resin, is selective for magnesium hardness and less than 0.1 ppm magnesium is obtained (measured by spectrophotometer) in the softened effluent at all times. Endpoint of the run is always evidenced by an increase in calcium hardness as shown in Fig. 4.

5. Average total hardness throughout a run is less than 0.5-0.8 ppm as measured by the sensitive versenate method with operating rates of less than 3.25 gpm per cu ft. Fig. 5 also shows the uniform quality of effluent obtained with some variations in influent hardness.

6. Samples of resin treated with dilute hydrochloric acid solution showed virtually no buildup of $CaCO_3$ or other precipitates after treating more than 1,000,000 gal per cu ft.

B. Treating Unfiltered Effluent From Hot Process Softeners (Turbidity Varying from 6-20 ppm)

1. No breakdown, same as A. above, after more than 360,000 gal per cu ft of resin were softened.

2. Drop in capacity from 24-26 kgr per cu ft down to 21.5 kgr per cu ft after about twenty-one unit regenerations treating more than 360,000 gal per cu ft of resin and employing 0.4-0.55 lb of salt per kgr of hardness removed.

3. Regardless of frequency of regeneration, backwashing of the resin zeolite must be accomplished at least once every 8 hr or when pressure loss across bed is 3 to 4 psig at a rate of 12 to 15 gpm per sq ft with hot water to keep the zeolite bed from accumulating solids and forming so-called "lime balls" which cause channelling and hardness leakage.

4. At operating rates of less than 1.5 gpm per cu ft (gravity flow), the same selectivity for magnesium is displayed as on filtered water but a slightly higher magnesium concentration of 0.2 ppm is obtained. Endpoint of the run is always an increase in calcium hardness as shown in Fig. 5.

5. Average total hardness throughout a run is always less than 1 ppm at operating rates of less than 1.5 gpm per cu ft.

6. Samples of resin treated with dilute hydrochloric acid solution showed the presence of slight amounts of $CaCO_3$ after treating 360,000 gal per cu ft. However, tests were not continued to the point where an appreciable drop in capacity was obtained in operation. This merely indicates that when operating on unfiltered water, provision should be made for ample backwashing rate at frequent intervals plus rotary surface washers to help keep the bed clear.

Unfortunately, all of the pilot plant work completed to date has been on first-stage effluent with soda ash excess treatment as normally employed. Accordingly, the possible effect of instability created by excess calcium treatment has not been checked in actual operation. However, practical operating experience with hot process reaction indicates clearly that virtually all reactions are completed within 10-15 min at high temperatures and no difficulty is anticipated from this factor.

Large Scale Installations of Hot Zeolite Softeners

At present, several larger scale installations are in operation, one at a midwestern chemical plant employing three 78 in. diameter by 4 ft straight softeners with Gravex RL-40, styrene base resin, on the unfiltered effluent from a 12,000 gph modified conventional-type hot process softener has been in operation, off and on since December 1949. (Ref. 7) Another 10,000 gph unit is being operated in the Midwest (Ref. 5) and an 8000 gph unit is in operation on the West Coast. (Ref. 8) Both of these latter plants operate with filters preceding the hot zeolite units.

At present, a number of larger plants are being installed. Figure 6 shows the flow sheet and general unit layout for the largest two-stage hot process, hot zeolite plant in the world being installed at an East Coast refinery and treating 200,000 gph of feedwater for 650 psi boilers with 90 to 100 per cent makeup. The first-stage treatment unit is of the Graver "Sphericone" design. Table II shows influent and effluent analysis to and from this equipment. Filters are being employed to precede the zeolite units.

Only lime will be fed, Table II, to reduce calcium hardness selectivity resulting in an effluent of 2 to 4 gr per gal total hardness from the 1st-stage treatment. The six 10 ft diameter by 5 ft 6 in. straight Gravex styrene-base resin zeolite units are designed for regeneration with 8 to 12 per cent sodium chloride solution at temperatures of 225 F and with contact times of 30 to 40 min to increase efficiency of regeneration and reduce salt dosages to less than 0.40 lb per kgr.

Fig. 6 shows a typical layout of four 10 ft diameter by 5 ft straight Gravex RL-40, styrene-base, hot zeolite softeners showing some details of the semi-automatic brine regeneration equipment, back pressure valves, etc. This indicates the practical design of the regeneration equipment required to avoid thermal "shock" on the resin zeolite by backwashing and regenerating at elevated temperatures (within 40 F of operating temperatures) and the back pressure valves prevent steam flashing or "binding" of the zeolite units.

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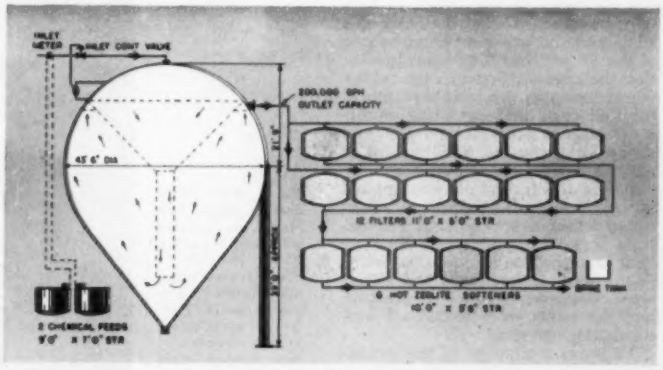
INLET METER
INLET CONT VALVE
200,000 GPH OUTLET CAPACITY
45' 6" DIA
12 FILTERS 11'0" x 5'0" STR
6 HOT ZEOLITE SOFTENERS 10'0" x 5'6" STR
2 CHEMICAL FEEDS 5'0" x 7'0" STR

Fig. 6. Flow diagram of Graver 200,000 gph hot zeolite softener installation at an Eastern oil refinery

Insulation Methods

for Steam-Electric Power Units

The design of the insulation for the piping, valves, heat exchangers, etc. in a large high pressure steam-electric generating station is as important, and involves as much knowledge and care as other more spectacular elements of the station. This article describes in detail the methods used and the kind of insulation installed on the new power units at the West End and Miami Fort Stations of the Cincinnati Gas & Electric Co.

By J. H. HEIMBROCK,
Superintendent, Miami Fort Station, Cincinnati Gas & Electric Company

ECONOMY AND efficiency of steam production and utilization have been among the primary goals of our stations since the first units were installed some 32 years ago. Considerable attention has, therefore, always been given to insulation design in plant engineering and construction. Since the insulation specifications developed for earlier units had proved so successful in attaining our goals, these specifications were used, with modifications to meet today's more rigorous operating conditions, for insulating the new units at our West End and Miami Fort Stations. (A detailed description of the design and operation of the new equipment appeared in the May issue of POWER ENGINEERING.) The insulation work was handled by R. E. Kramig & Co., Inc., of Cincinnati.

Diatomaceous silica and 85 per cent Magnesia, either individually or in combination, were the materials used. The combination is desirable in that it takes advantage of the resistance to the effects of high temperatures of the diatomaceous silica and the low heat conductivity of the 85 per cent Magnesia. Insulation thicknesses, listed in the tables, were chosen as the most economical for fuel costs and operating conditions, such as hours of operation and steam temperatures, now current in our plants.

Before the insulation was applied all surfaces were wiped clean of construction debris so that a close, tight fit would be obtained. To keep heat loss down to a minimum, joints in the sections, segments and blocks were staggered wherever possible, and the joints were sealed off with insulating cement.

To prevent slippage of the insulation on long vertical runs of pipe, studs or clip angles were spot-welded to pipe surfaces.

Special pipe hangers which fit around the insulation were installed on high-pressure steam lines, so that heat loss which would occur due to direct contact between the hot surface of the pipe and the pipe hanger is avoided. Construction of this type of hanger was fairly simple. A steel plate, its length proportioned to the load to be carried, was rolled to fit the insulated pipe and provided with a flange for assembly. Then a saddle plate designed so as to help carry and spread the load in proportion to the bearing capacity of the insulation was tack-welded to the lower section of the flanged plate. The flanged plate was then bolted around the insulated pipe and the entire assembly supported in the usual manner.

Where flanged joints occur in pipe lines, a short piece of insulation was wired around the pipe next to the flange at either side of the joint. Thus, these pieces of insulation can be removed and the bolts taken out of the flanges without disturbing the insulation on the rest of the line. The flanges themselves were covered with sectional insulation extended to fit over the adjacent pipe insulation. If the flanges were too large in diameter for sectional insulation, the flange insulation was constructed in the field. A template or wire frame

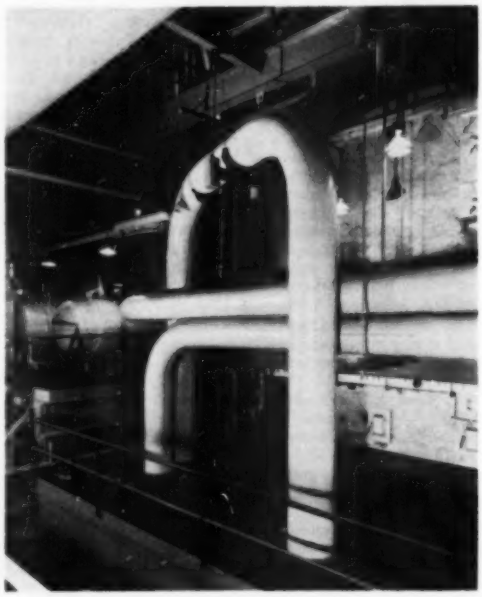

Fig. 1. Main steam lines at Miami Fort Station are insulated with combination 85% Magnesia-diatomaceous silica, and finished with canvas jacket. Note flanged plate bolted around insulation at pipe hangers. Heat exchangers in rear are also magnesia-insulated

of galvanized wire mesh was formed in two halves to fit the flange, block insulation was wired on over the mesh, and insulating cement was then troweled on. The unit was then wired in place over the flange.

Valves, traps and fittings were insulated with material of the same kind and thickness as that specified for the adjacent piping. The insulation was applied either in the form of cement or molded sections, segments or blocks. If molded insulation was used, it was cut to fit the surface and wired in place with a sufficient number of wire loops so that a firm installation was obtained. All cracks and voids were filled with cement and the entire surface smoothed over with cement.

Insulation on heaters and on the

(Continued on page 122)

Fig. 2. (Right) General view of steam and feedwater piping at West End Station. Insulation is diatomaceous silica and 85% Magnesia, used alone or in combination. Finish is canvas.

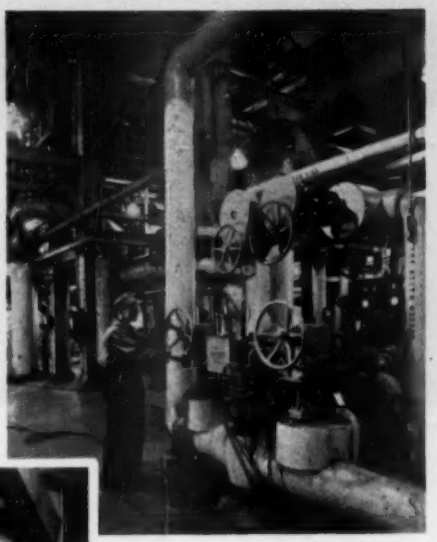

Fig. 3. (Below) Heat exchanger and steam lines at West End Station. These are insulated with 85% Magnesia, and finished with canvas jacket. Note careful insulation of heated valves and flanges.

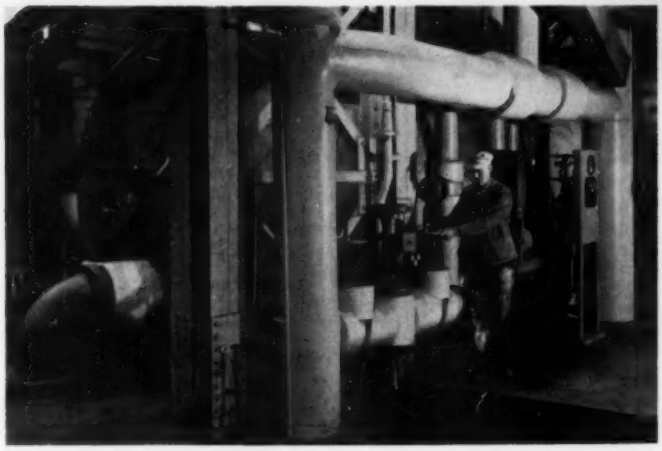

TABLE II — EQUIPMENT INSULATION

Equipment	Temperature	Insulation
Low pressure heaters	230 F	1½ in. 85% Mag.
Deaerating heaters with domes and vent condensers	315 F	2½ in. 85% Mag.
High pressure heater	410-470 F	3 in. 85% Mag.
Evaporator	315 F	2½ in. 85% Mag.
Drain tanks	200 F	1½ in. 85% Mag.
Filters	230 F	1½ in. 85% Mag.
Heat exchangers	200 F	1½ in. 85% Mag.
Water softeners	230 F	2 in. 85% Mag.
Scroll housing and inlet boxes on I.D. fans	360 F	2½ in. 85% Mag.
Flue gas ducts	360 F	2½ in. 85% Mag.
Hot air ducts	585 F	1½ in. D. 2 in. 85% Mag.

D. = Diatomaceous silica
85% Mag. = 85% Magnesia

TABLE I — PIPE INSULATION

Piping	PIPE SIZE 1½ in. and smaller	2 - 4 inches	6 inches and larger
960 F: Main high pressure superheated steam and drains	2½ in. D.	1¾ - 2 in. D. 1½ in. 85% Mag.	2½ in. D. 2½ in. 85% Mag.
775 F: Extraction steam and drains	2 in. D.	1¾ - 2 in. D. 1½ in. 85% Mag.	2 in. D. 2 in. 85% Mag.
750 - 501 F: Extraction steam High pressure saturated steam Low pressure steam Exhaust steam Drain	2 in. D.	1¼ - 1-9/16 in. D. 1½ in. 85% Mag.	1½ in. D. 2 in. 85% Mag.
500 - 351 F: Extraction steam High pressure heater Low pressure steam High pressure boiler feed	1½ in. 85% Mag.	2 in. 85% Mag.	2-5/16 - 3 in. 85% Mag.
350 - 251 F: Boiler feed Evaporators Drains	⅞ in. 85% Mag.	1-1/32 - 1⅛ in. 85% Mag.	2 in. 85% Mag.
250 - 80 F: Extraction steam Low pressure heaters Condensate Softened water Drains	⅞ in. 85% Mag.	1-1/32 - 1⅛ in. 85% Mag.	1⅛ - 1½ in. 85% Mag.

D. = Diatomaceous silica 85% Mag. = 85% Magnesia

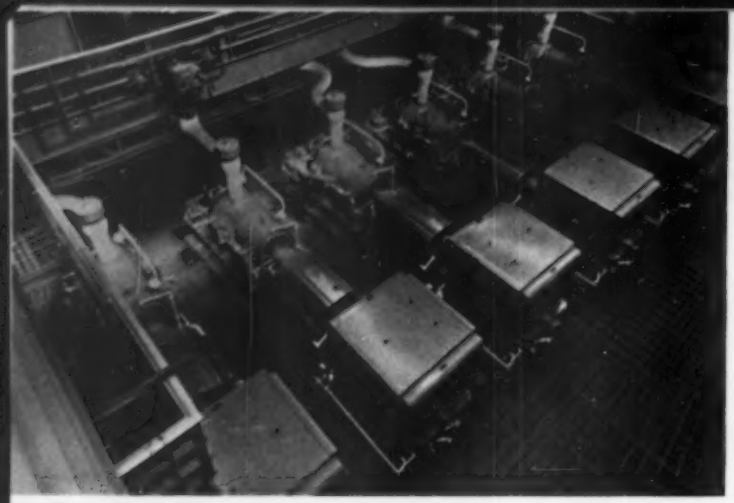

Fig. 1. View of the six 6-in. solid-forged-steel barrel, 8-stage boiler feed pumps, for 522,500 lb per hr each of 265-F water, 79 psi suction pressure, 1974 psi discharge pressure, at Sewaren Generating Station, Public Service Electric & Gas Co., (N. J.). Pumps driven by 2000-hp motors through variable-speed hydraulic couplings

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How to Select *Centrifugal*

WITH THE TREND towards higher operating pressures, importance of the boiler feed pump has increased yearly and need of more complete understanding of boiler feed pump design and selection has become more pressing as the requirements imposed upon these pumps have grown in magnitude. It is encouraging, however, to note the growing interest taken in this subject by power plant operators as well as by centrifugal pump engineers.

Our present object, therefore, is to place information in the hands of the power plant engineer to help him determine the conditions of service required of the feed pumps for his power plant, what data he needs to furnish to the manufacturer in order to get an intelligent bid, and what particulars he must obtain from the manufacturer in order to judge the latter's bid intelligently.

Conditions of Service

The first step in preparing specifications for the purchase of the boiler feeding equipment consists in determining the conditions of service under which it will operate. While it is possible on the basis of preliminary heat balance calculations to approximate these conditions at the time the power plant is being laid out, the final conditions can be established only after the turbine generator, boiler, and some of the auxiliary equipment have been selected.

In general and under normal production conditions, the time element involved in the manufacturing of the major power plant equipment such as main turbines and boilers is appreciably longer than that required to complete the boiler feed pumps and their drivers. This allows a certain delay between the purchase of the main equipment and the issue of boiler feed pump specifications, with the result that the feed pump conditions of service can be established quite accurately.

Under the general term, "conditions of service," there is included not only the pump capacity, discharge pressure, suction conditions, and feedwater temperature but, in addition, such data as the chemical analysis of the feedwater, the pH at pumping temperature, the variation in suction pressure and temperature, and any other pertinent data which may reflect upon the hydraulic and mechanical design of the boiler feed pumps. It is highly imperative that all information pertaining to the conditions of service under which the boiler feed pumps are to operate be clearly outlined.

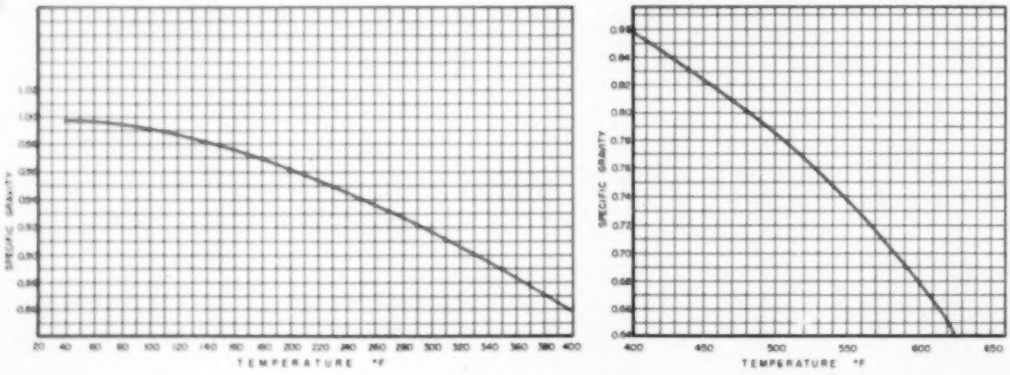


Fig. 2. Specific gravity of water versus temperature

To obtain the right centrifugal boiler feed pump to fit YOUR conditions, here's what you must do . . . First, you must analyze correctly and accurately the conditions under which it will operate; second, give the manufacturer proper information; third, know how to judge the manufacturer's bid intelligently . . . Water weighs less at higher temperature; figure on it in calculating capacity . . . What effect does pump wear have? . . . How many pumps do you need? . . . Instructions for figuring NPSH and net discharge pressure accurately . . . Submergence very important . . . Comparing designs . . . Constant-speed and variable-speed operation—how do they affect NPSH, capacity, discharge pressure, pump control? . . . System head curves and what they mean . . . What does a feedwater regulator do? . . . Total head at varying temperatures . . . When you have analyzed all these factors, you can tell the pump manufacturer the required discharge pressure, possible variations in suction conditions and temperature—and get the right pump

Boiler Feed Pumps

Thus, whenever there is any doubt in the mind of the power plant designer, a complete layout of the feedwater system and of the heat balance diagram should be supplied to the boiler feed pump manufacturer. The study of this layout will often permit the manufacturer to suggest an alternate arrangement of the boiler feeding equipment that would result in a more economical operation, in decreasing the first cost of the installation, or even in improving the life of the equipment in such a manner as to reduce the eventual maintenance expense.

Boiler Feed Pump Capacity

First in the order of the conditions of service to be determined comes the capacity to be handled by the boiler feed pump. It becomes necessary to establish the absolute maximum steaming rate of the boilers to be served with blowdown valves fully open.

It is advisable to point out here a common oversight on the part of power plant operators with respect to the conversion of capacities expressed in pounds per hour into gallons per minute. For obvious reasons all heat balance calculations as well as all turbine and boiler guarantees are expressed in pounds per hour whereas it is customary to define the service to be performed by the centrifugal pumps in terms of gallons per minute (volume per unit of time) against a head of so many feet.

To convert pounds per hour into gallons per minute, it is necessary to remember that the average boiler feed pump handles water at high temperatures. Now, the density of water is greatest at 39.1 F and, by definition, the specific gravity of water at that temperature is 1.00. One gallon of water at 39.1 F weighs 8.33 lb, and since the density of water decreases with increasing temperatures, it will weigh less than 8.33 lb at higher temperatures in accordance with the relation:

Weight of one gallon of water = 8.33 lb × specific gravity at the desired temperature. In order to convert pounds per hour into gallons per minute, it is necessary, therefore, to use the following formula:

$$\text{Gpm} = \frac{\text{Lb per Hr}}{60 \times 8.33 \times \text{specific gravity}} = \frac{\text{Lb per Hr}}{500 \times \text{specific gravity}}$$

Values of the specific gravity of water for varying temperatures are given in Fig. 2 and can also be found conveniently in standard steam tables.

It is immaterial to the manufac-

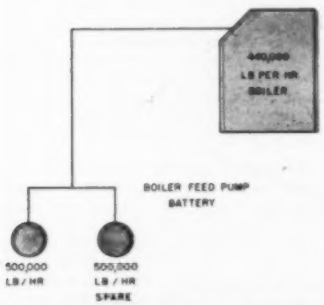


Fig. 3. Typical boiler feed pump installation to serve a 440,000-lb-per-hr boiler, with one pump designed for full load plus provision for wear and swings and one duplicate spare

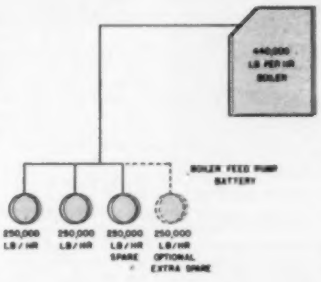


Fig. 4. Here the load, with the boiler operating at full rated capacity, is split between two pumps operating in parallel. One or two spare pumps may be installed

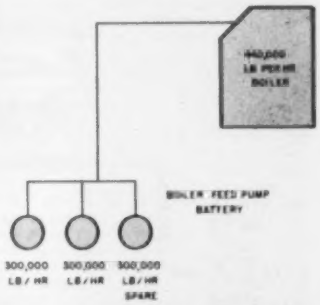
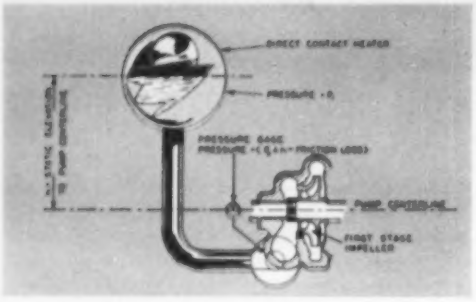
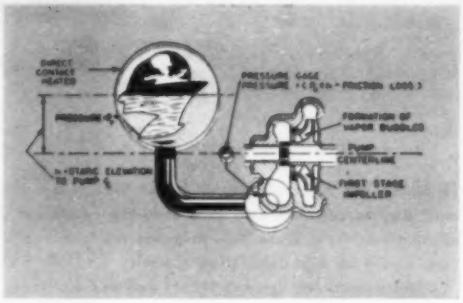


Fig. 5. Since the normal load is only 300,000 lb per hr, one pump can be used at all times except at peak loads, when the second unit is put on the line





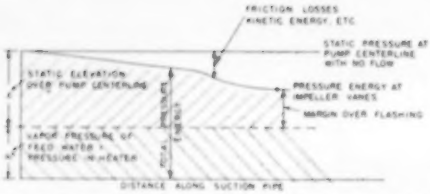

FRICTION LOSSES
KINETIC ENERGY, ETC
STATIC PRESSURE AT PUMP CENTERLINE WITH NO FLOW
STATIC ELEVATION OVER PUMP CENTERLINE
PRESSURE ENERGY AT IMPELLER VANES
MARGIN OVER FLASHING
VAPOR PRESSURE OF FEED WATER + PRESSURE IN HEATER
DISTANCE ALONG SUCTION PIPE

Fig. 6. Transformation of energy between direct-contact heater and pump impeller

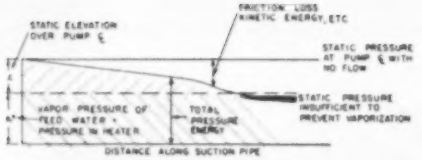

STATIC ELEVATION OVER PUMP
FRICTION LOSS
KINETIC ENERGY, ETC
STATIC PRESSURE AT PUMP WITH NO FLOW
STATIC PRESSURE INSUFFICIENT TO PREVENT VAPORIZATION
VAPOR PRESSURE OF FEED WATER + PRESSURE IN HEATER
TOTAL PRESSURE ENERGY
DISTANCE ALONG SUCTION PIPE

Fig. 7. Insufficient pressure margin over flashing because the heater is not high enough above the pump

turer whether you specify the pump capacity in lb per hr or in gpm as long as you have used the proper conversion in establishing the capacity in gpm. The importance of taking the specific gravity into consideration can be made obvious when it is considered that neglecting this correction acts to reduce the available capacity by an appreciable amount. For instance, if pumping temperature is 250 F (specific gravity = 0.944), an error of almost 7 per cent on the short side would result.

Provision For Wear

Complete absence of wear in machinery is an unattainable goal. This is a situation to which both designers and users of machinery have reconciled themselves, but fortunately they have not given up the attempt to approach perfection in this regard.

It is a common belief that the wear which takes place in a centrifugal pump causes a reduction of efficiency. This, of course, is only a half-truth, as will become apparent immediately. Wear occurs at the running joints, such as the wearing rings, the interstage diaphragms, and the balancing device if any is used. Such wear is normal, expected, and provided for by the use of renewable parts, which can be replaced at a nominal expense after a reasonable length of service.

Strictly speaking, the real pump efficiency is not affected by this type of wear. Each impeller still delivers as much feedwater against the same pressure and takes no more power in the process. However, as the running clearances increase with wear, a greater portion of the feedwater pumped by each impeller is short-circuited through the running clearances back to the lower-pressure stage from which the impeller has picked it up. In other words, the effective capacity of each impeller and therefore of the boiler feed pump has been reduced materially. Inasmuch as the power consumption for a given gross capacity remains the same while the net capacity is reduced, the effective efficiency of the boiler feed pump is of course reduced in proportion to the increase of the short-circuit losses.

Obviously, it is imperative to provide for this ultimate reduction in the effective capacity of a boiler feed pump at the time of the selection of its design capacity. It is practically impossible to establish any fast rules for providing this margin of safety, but it can be said that a margin of at least 10 per cent in excess of the absolute maximum boiler requirements is advisable. Frequent-

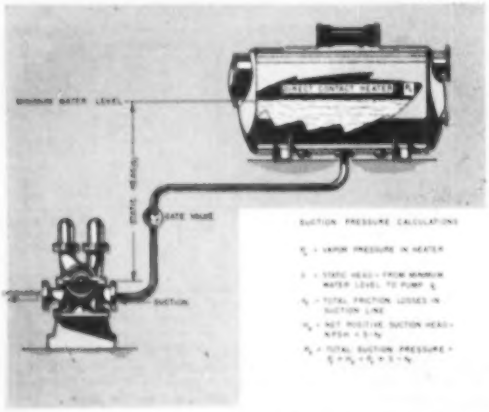


Fig. 8. How to determine suction conditions

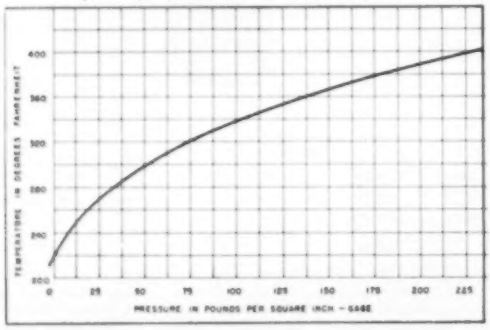


Fig. 9. Vapor pressure of water versus temperature

ly, a margin of as much as 20 per cent is provided.

Number of Pumps

The choice between use of a single boiler feed pump per boiler and installation of several boiler pumps in parallel for the full boiler demand is often influenced by the nature of the power plant load. In a base load station, the tendency is to design the boiler feed pump for the full capacity corresponding to the maximum steaming rate. If, on the other hand, the load is of a fluctuating nature, two or more pumps may be operated in parallel.

At periods of light load, it is desirable that one or more pumps be taken off the line to allow more efficient operation. The capacity of the individual pumps is selected frequently with this manner of operation in view. For instance, if the plant load remains at 65 per cent of maximum capacity most of the time, two boiler feed pumps each designed for 65 to 70 per cent of maximum flow could be installed. Thus, for the major portion of the time, one pump alone would be able to carry the load. When the total flow exceeds 65 per cent of maximum, the second boiler feed pump is put on the line, the two pumps sharing the load and operating in parallel.

Exceptions

However, there may be certain exceptions to this general practice:

(1) When the total capacity is too low to be split up effectively between two pumps, a single pump may be used regardless of the nature of the plant load.

(2) When the efficiency of operation is inconsequential, as, for instance, when the boiler feed pumps are turbine-driven and the exhaust steam is used for process work or for heating, first cost will generally determine the number of boiler feed pumps to be used.

(3) When the maximum capacity is too great to permit the use of the most efficient pump, the capacity may be split up between two or more pumps.

Operating Schedule

If a single boiler feed pump is used per boiler and no cross-connection is available from adjacent boiler headers, it becomes advisable and necessary to arrange the installation so that a spare pump can be put on the line immediately upon failure or stoppage of the main feed pump.

Since this substitution must be provided for the interruption of the prime mover as well as for pump failure, it is the general practice to use a different motive power for the spare pump.

If the main feed pump is motor-driven, the spare pump would be turbine-driven. The switch-over to the spare pump can be accomplished automatically in any one of several manners. The actual process is a problem of controls somewhat beyond the scope of the present article. The impulse for the controlling mechanism can be either the interruption of current in a solenoid-operated pilot valve or the decrease of pressure in the discharge header from the boiler feed pump.

Frequently, one boiler feed pump may be used to feed a number of boilers of equal or of varying sizes but all operating at the same pressure. The method of determining the boiler feed pump capacity in such case differs in no way from the method previously described.

Suction Conditions

A very large portion of the various operating problems that arise in conjunction with boiler feed pumps can be traced directly to suction conditions. Unsatisfactory suction conditions may assert themselves, first, by symptomatic undue noises in the first stage of the boiler feed pump; second, by failure to deliver the required capacity; and finally, by the untimely wear of the first-stage impeller and, not infrequently, by the complete failure and breakdown of the pumping unit.

In any centrifugal pump, there is a definite friction and velocity head loss which takes place before the liquid enters the impeller vanes to a degree sufficient for it to receive energy from the pump. When water enters the suction of the first-stage impeller of a centrifugal pump, a certain amount of pressure energy is therefore converted into kinetic energy, the exact amount of this conversion depending upon various features of the suction passage and impeller inlet design.

Strictly speaking, of course, the reference should be made to changes in energy per unit mass as velocity heads are not really "energy" but rather "energy per unit mass." However, it is accepted practice to use the term "kinetic energy" interchangeably with "velocity head" and "pressure energy" with "static intensity of pressure."

This transformation of energy is illustrated in Fig. 6, where the first stage of a boiler feed pump is shown taking its suction from a direct-contact or open heater. In order to prevent flashing of the water before it has had a chance to receive additional pressure energy from the impeller, it is necessary to avoid lowering the pressure energy at the impeller vanes below the vapor pressure.

If the static pressure at the impeller vanes should fall below the vapor pressure corresponding to its temperature, as in Fig. 7, a portion of the water contained in the impeller suction would immediately flash into steam. This flashing will form vapor-filled cavities within the body of the flowing water and cavitation, as this phenomenon is called, will take place. The immediate effect of cavitation is to prevent a further increase of the pump capacity, as the pumping space normally alloted to the flow of water is occupied by steam.

This, however, is not the sum total of the effects of cavitation. As the steam bubbles pass on to regions of the impeller under somewhat higher pressure, they condense in a sudden collapse with all the characteristics of an explosion. As a

The Author

IGOR J. KARASSIK is an application engineer and Assistant to the Manager in the Centrifugal Pump Division of the Worthington Pump and Machinery Corp.

Born in Russia, he emigrated to Turkey in 1919, then to Paris, in 1924, where he graduated from high school. Coming to the United States in 1928, he received his B.S. and M.S. degrees from Carnegie Institute of Technology, having specialized in research work in the field of hydro-aerodynamics. He is a member of Tau Beta Pi, Pi Tau Sigma, and Sigma Xi, honorary research fraternity.

He was employed by Worthington in 1934, as assistant to the Consulting Engineer on Centrifugal Pumps and was engaged in research and design work on single and multi-stage pumps. Since 1936 he has specialized in the application of multi-stage high-pressure pumps, especially for power stations. His work has also included development and design of improved boiler feed cycles for central station power plants, a field in which he holds several patents.

He has written numerous articles on centrifugal pumps for technical publications: as of April 1950, a total of 116 articles. Including reprints and translations, his articles have appeared in 249 magazine issues, in 32 different magazines and in 6 languages. He is a co-author of the book *Pump Questions and Answers*. In 1940, 1942 and again in 1944 he received the first prize in the Hydraulic Institute Engineering Essay Contest.

To regular readers of *Power Engineering* (under its previous titles *Power Plant Engineering* and *Power Generation*) Mr. Karassik's name is a familiar one. He has contributed such outstanding material as his famous and exclusive series on Centrifugal Pump Control in 1945 and other articles too numerous to list. His articles on Constant and Variable-Speed Boiler Feed Pump Operation, and other phases of operation, have been used by thousands of power engineers.

The material in the present article has been completely rewritten from articles and portions of articles published in this and other magazines about 10 years ago. Since that time a great deal has been learned about boiler feed pumps and, in the light of that new knowledge, the author has brought everything up to date. In another later article, he will tell Why and How Centrifugal Boiler Feed Pumps Operate as They Do.

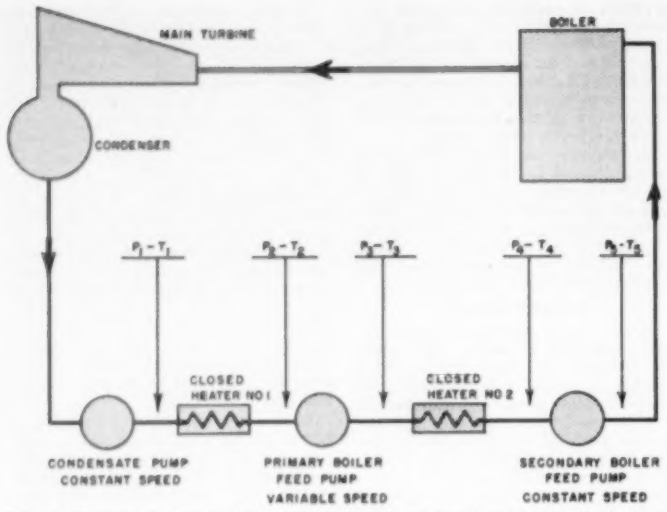


Fig. 10. Diagram showing a closed feed cycle with variable-speed primary feed pump

matter of fact, a word, "implosion," has been coined to describe the phenomenon. This violent collapse produces water-hammer pressures of great intensity on small localized areas of the impeller. The pitting of the suction areas of an impeller that has been subjected to cavitation is too common a sight for power plant operators to require further explanations.

It is somewhat difficult to measure the static pressure at the impeller entrance proper, and, therefore, it is the practice of pump designers to specify the required pressure as measured at the pump suction flange and referred to the pump horizontal centerline. This pressure is determined for a given pump and for a given capacity on the basis of the calculated or predicted friction head losses previously mentioned.

What Is NPSH?

In boiler feed pump terminology, the NET POSITIVE SUCTION HEAD or NPSH represents the net suction head over the pump suction referred to the pump centerline *over and above* the vapor pressure of the feedwater. The reason for use of this definition lies in the fact that incipient cavitation must be expected to take place as soon as the static pressure at some one point within the pump has dropped to the value of the vapor pressure and vaporization begins. This definition of suction head renders it automatically independent of any variations in temperature and vapor pressure of the feedwater.

The feedwater in the storage space of a direct-contact or open heater, from which the boiler feed pump takes its suction, is under a pressure corresponding to its temperature. Therefore, the only energy available at the first-stage impeller over and above the vapor pressure is the static submergence between the water level in the storage space and the pump centerline, less whatever friction losses take place in the intervening piping.

How to Find NPSH

The method of determining the available NPSH (net positive suction head) and the total suction pressure for an installation where the boiler feed pump takes its suction from a direct contact heater is illustrated in Fig. 8. A typical calculation of prevailing suction conditions follows.

Let it be assumed that:

Temperature in direct contact heater ..... = 250F
Specific gravity at 250F ... = 0.944
Pressure in heater (vapor pressure at 250F) ..... = 15 psig
Static head from minimum water level to pump centerline = 21 ft
Friction losses at rated capacity:
in piping ..... = 1.5 ft.
in valves ..... = 2.5 ft
Total ..... = 4 ft

Then:

Net positive suction head = 21 - 4 = 17 ft

Total suction pressure =

$$15 + \frac{17 \times 0.944}{2.31} = 22 \text{ psig}$$

For ready reference, Fig. 9 gives the relationship between the vapor pressure of water and its temperature.

The required NPSH for a given pump, operating at a given speed, is a function of the pump capacity, varying approximately as the square of the capacity. Likewise, for a given set of operating conditions of capacity and head per stage, the required NPSH is a function of the operating speed, increasing with higher speeds and decreasing at lower speeds.

The NPSH recommended by the Hydraulic Institute for various capacities over a range of speeds of 1750 to 3600 rpm and for both single and double suction first stage impellers can be found in the Hydraulic Institute Standards (obtainable from the Hydraulic Institute, 90 West Street, New York, N. Y.)

It has been stated previously that the net positive suction head required for a given pump and a given capacity is independent of the operating temperature by virtue of its definition. Practically, however, this temperature should be taken into consideration when establishing the recommended submergence from a direct-contact heater to the boiler feed pump. A margin of safety should be added to the theoretically-computed NPSH when the boiler feed pump handles feedwater at

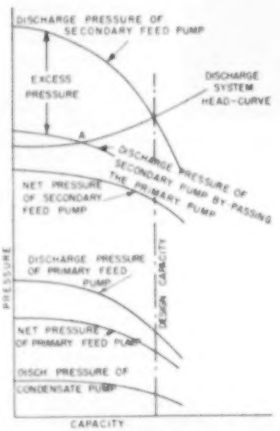

DISCHARGE PRESSURE OF SECONDARY FEED PUMP
EXCESS PRESSURE
DISCHARGE SYSTEM HEAD-CURVE
DISCHARGE PRESSURE OF SECONDARY PUMP BY PASSING THE PRIMARY PUMP
NET PRESSURE OF SECONDARY FEED PUMP
DISCHARGE PRESSURE OF PRIMARY FEED PUMP
DESIGN CAPACITY
NET PRESSURE OF PRIMARY FEED PUMP
DISCH PRESSURE OF CONDENSATE PUMP
PRESSURE
CAPACITY

Fig. 11. Characteristics of closed feed cycle at constant speed

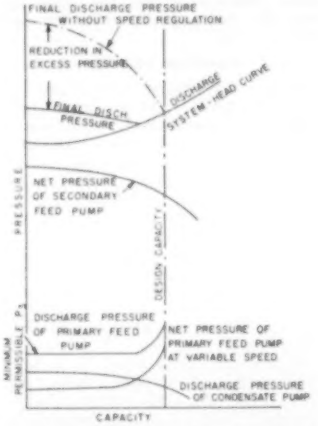

FINAL DISCHARGE PRESSURE WITHOUT SPEED REGULATION
REDUCTION IN EXCESS PRESSURE
FINAL DISCH PRESSURE
DISCHARGE SYSTEM HEAD CURVE
NET PRESSURE OF SECONDARY FEED PUMP
PRESSURE
DESIGN CAPACITY
DISCHARGE PRESSURE OF PRIMARY FEED PUMP
NET PRESSURE OF PRIMARY FEED PUMP AT VARIABLE SPEED
MINIMUM PERMISSIBLE P_s
DISCHARGE PRESSURE OF CONDENSATE PUMP
CAPACITY

Fig. 12. Characteristics of a closed feed cycle with variable speed regulation

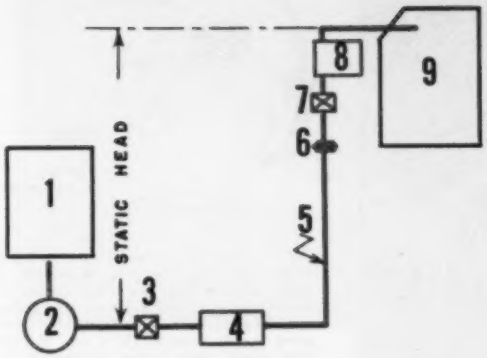


Fig. 13. How to determine discharge pressures

NOMENCLATURE
1 Direct contact heater
2 Boiler feed pump
3 Excess pressure regulator
4 Closed heater
5 Piping and valves
6 Flowmeter
7 Feedwater regulator
8 Economizer
9 Boiler

temperatures over 250F. This margin of safety cannot be expressed as a mathematical formula, but past experience will dictate to the pump manufacturer what magnitude this margin should reach.

The reasons for the use of such a margin are two-fold:

a) The higher the operating pressure and temperature, the greater will be the fluctuations in pressure experienced in the direct contact heater and the greater the opportunity for a time lag between a reduction in pressure and a corresponding reduction in temperature at the pump suction.

b) A greater pressure is required to re-compress a steam bubble at the higher temperatures. Thus, at these temperatures, a centrifugal pump has less chance to clear itself of steam if it has started to cavitate through some abnormal occurrence in its operation—unless a safety margin is included in the submergence available over the required net positive suction head.

Recommended values for this margin are likewise given in the Hydraulic Institute Standards.

Selecting Submergence

One cannot overemphasize the importance of securing satisfactory suction conditions for the proper operation of boiler feed pumps. The most important factor for such operation is that sufficient submergence be provided over the suction of the pump, in order to prevent even partial cavitation and local flashing in the vanes of the first-stage impeller. Insufficient suction heads are not conducive to the selection of a good, substantial and economical pumping unit.

As an example, let it be assumed that the desired boiler feed pump capacity is 400 gpm of 215F feedwater, with a net pressure to be generated at 650 psi. An adequate selection for these conditions would be a 6-stage, 4-in. pump operating at 3550 rpm and requiring 15 ft NPSH. Of course, it would be possible to design a boiler feed pump which could handle 400 gpm at that speed with a net positive suction head of only 6 to 8 ft. Such a pump, however, would have to be designed for a maximum efficiency at a capacity of from 40 to 60 per cent higher than the 400 gpm it could handle with the low submergence available. It is obvious that such a solution is far from satisfactory in that it will necessitate operation at a poor efficiency condition, with resulting high operating cost, to say nothing of the higher first cost of such a pump and of the unfavorable effect of operating a pump constantly too far back on its curve.

As a matter of fact, regardless of the consequences, a reliable pump manufacturer would not consider furnishing a boiler feed pump unless an adequate net positive suction head were available. This does not mean that it is absolutely impossible to design boiler feed pumps capable of operating with extremely low submergence, but such pumps are inherently very inefficient, for they must either be designed for greater capacities under normal conditions or else be of the "hotwell" or condensate removal type, with very poor efficiency and operating at low speeds.

It is seldom the practice of power plant construction engineers to squeeze equipment into such limits that the pump manufacturer is seriously handicapped in the selection of the boiler feeding equipment. At the same time, it is always advisable to check with the manufacturer with respect to the required submergences prior to completing the layout of a newly-designed power plant, so as not to find, too late, that the available submergence is too low for proper operation and that the plant layout can no longer be changed to suit.

Design Comparison

Once in a great while, in the zeal of insuring proper suction conditions and to make sure that the manufacturer does not skimp on the design of the first-stage impeller, a specification will call for a tabulation of the eye diameter and suction area of this impeller. Such information, unfortunately, is of but little help in evaluating the relative suction characteristics of several given pumps, for these dimensions are in no way a positive measure of minimum net positive head requirements.

Other factors, such as the shape and number of the impeller vanes, the area between these vanes, the shaft and impeller hub diameters, the impeller specific speed, the shape of the suction passages and many more enter as well, in some form or another, into the determination of the head required on the suction. Whether all these factors could be made to yield a simplified method of determining the required NPSH is difficult to state, as different pump designers use different methods to accomplish the same results.

It is obvious, however, that no single one of the factors listed can be evaluated exclusively of the others; therefore the knowledge of the value of one or two of these factors can serve no useful end, other than to confuse the issue if used as a basis of comparison.

In line with these reflections, it is advisable to caution the prospective specification writer and tabulation analyst that comparison of suction nozzle diameters is also of little value. The velocity head at the nozzle opening is of an entirely different order of magnitude in comparison to the NPSH and, therefore, even if the feedwater could know where the suction piping ends and where the pump begins, the size of this nozzle could play but a negligible role in establishing the required net positive suction head.

(Continued on page 106)

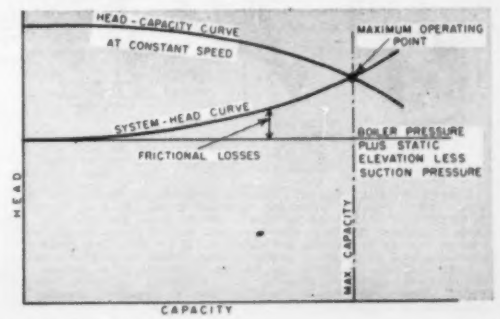
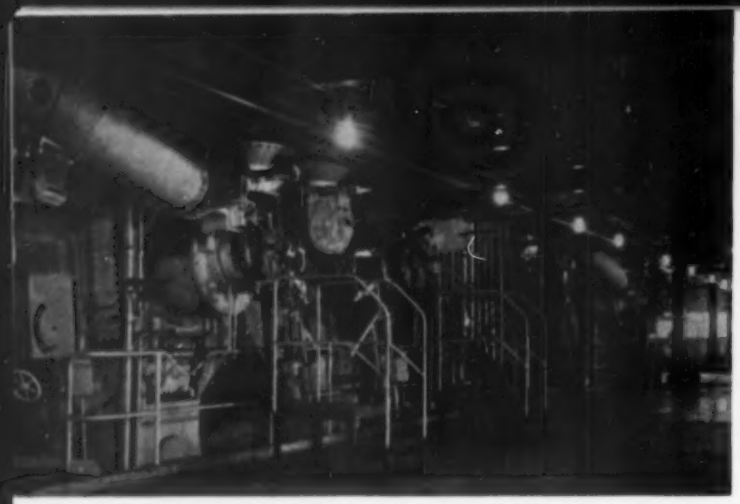


Fig. 14. System—head curve



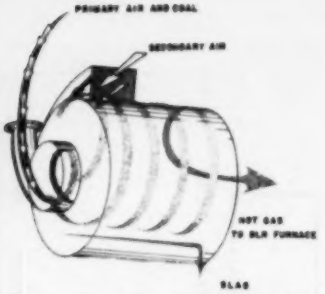


Fig. 1. View of cyclone furnaces firing steam generating units Nos. 14 and 15 in South Power Station, new power station of Dow Chemical Co. at Midland, Mich. This was designed to ease a tight steam and power supply situation. It is one of four large power plants serving Midland works. It was first operated in June 1950 and formally dedicated during week of July 24, 1950. Outstanding features on opposite page; details of equipment on page 71

This view shows two cyclones firing each of two 400,000-lb-per-hr 1250-psig, 830-F boilers, which supply steam through a 30,000-kw double-extraction turbine generator, Fig. 6, to the 425-psig and 165-psig plant steam systems and exhaust steam at 25-psi to a third system. Space at far right for two future similar units and another turbine generator.

Principles of operation and details of construction of the cyclone furnace were given in article Dow Installs First Industrial Cyclone Units, **Power Generation,** March 1949, page 78. This described the pioneer Dow installation, Boiler No. 13, located in the existing West Side Power Station of the company.

Further data on the construction and operation of the cyclone furnace were given in a general article, The Cyclone Furnace—Latest Thing in Coal Burning, by F. X. Gilg, **Power Generation,** April 1950.

Because all three of these new cyclone-fired boilers must operate with 100 per cent make-up, a complete new water treatment system of the demineralising type, capable of producing all the required pure water, was installed in a separate building, at left of Power Station, Fig. 3.

This water treating system is completely automatic in operation, uses anion and cation exchangers, fluorides for silica removal and spherical bitumastic-lined deaerators operating under 29.5 in. vacuum. The resulting water is so pure it must be handled in rubber-lined piping so it will not react with pipe metal. The resulting feedwater for the boilers contains 0.0 ppm silica, not over 2 ppm CO_2 and 0.1 ppm oxygen. Development of this automatic water treating system is a major factor in making this cyclone-fired boiler development possible.

The water system was described in a paper, Demineralisation Supplies 100% Makeup for 1250-psi Steam Generator, by Louis Wirth, before the 10th Annual Water Conference, October 1949.

Dow's *South Power Station*— Last Word in Industrial Power

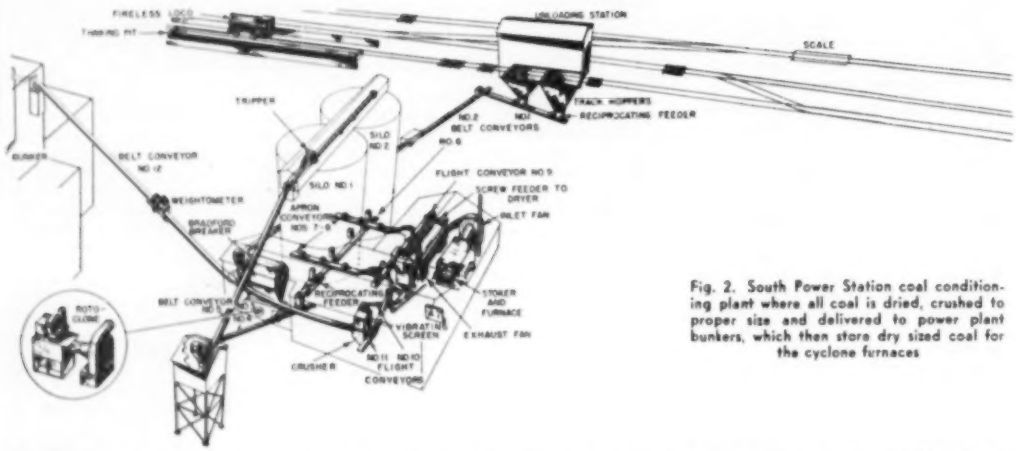


Fig. 2. South Power Station coal conditioning plant where all coal is dried, crushed to proper size and delivered to power plant bunkers, which then store dry sized coal for the cyclone furnaces

Operating experience with initial cyclones on Boiler No. 13 in West Power Station indicated desirability of avoiding interruptions in fuel feed, such as might result from wet coal. So the Dow engineers provided this separate conditioning plant where coal is crushed to desired size and dried as needed. This keeps coal handling and preparation problems out of the main power house.

Coal cars are handled by fireless locomotive; if frozen, are thawed over gas-fired thawing pit; unloaded to track hoppers. From hoppers, belt conveyors carry coal to Bradford breaker, for reduction to 1½ in. top size, thence conveyors 3, 4 and 5 deliver it to either of the two storage silos. From silos, coal flows to rotary dryer, which reduces moisture to 4 per cent. Separate stoker-fired furnace supplies hot air for drying. From dryer, coal goes to vibrating screen, which separates ¼-by-0-material for direct delivery to overhead station bunkers. Oversized coal goes to a crusher for reduction to ¼ in., thence to power station bunkers. All equipment controls are centralized, and interlocked to shut down equipment behind any unit stopped by power failure. Collecting system picks up dust at various units, to be transported pneumatically to a precipitator.

Fig. 3. General view of Dow Chemical Co's. new South Power Station at Midland, Mich., adding its output of 800,000 lb per hr of steam and 30,000 kw to existing power plants. This brings total Dow power plant capacity to 3,000,000 lb steam per hr and 110,000 kw of power

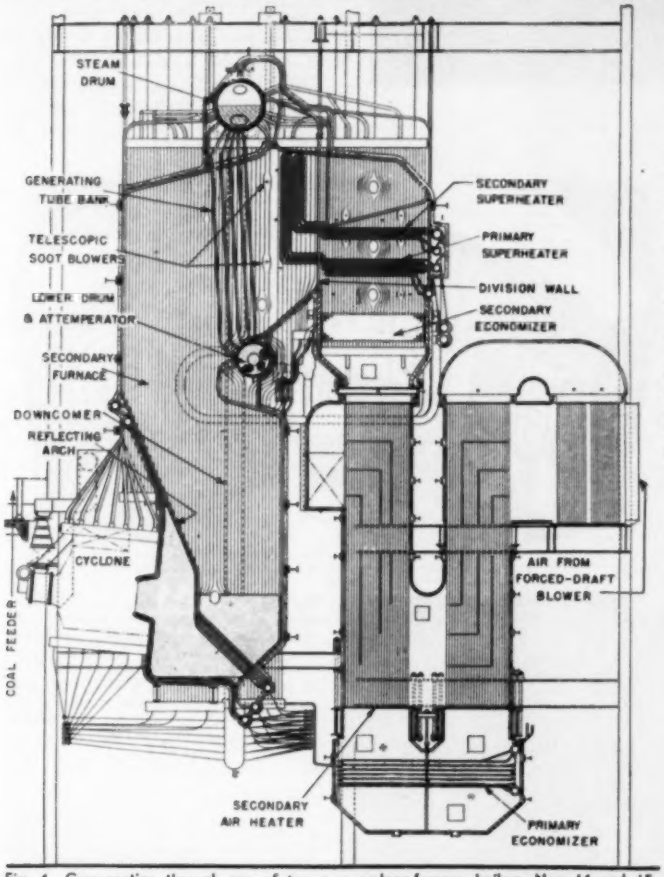


Fig. 4. Cross-section through one of two new cyclone-furnace boilers, Nos. 14 and 15, South Power Station

Original No. 13 boiler installed in 1949 to give good performance on low-grade coal with reduced fly ash emission. New Boilers 14 and 15 same in principle but improved in details. Hydraulic sluice or slag disposal not shown here.

Position of centrifugal blowers is behind air preheater instead of above. Blowers are controlled so that when air is supplied from inside building, automatic control prevents vacuum in building of more than $\frac{1}{4}$ in. water.

On Boiler 14, feeder consists of chain carrying discs running with very close clearance through long tube. Coal is fed between discs and close clearance in tube prevents pressure on discharge side from working back. Discs discharge coal to vibrating pan (to smooth out flow) and into primary air stream flowing to the cyclone.

On Boiler 15, the feeder is an apron type conveyor discharging to a skimmer plate (to smooth out flow) then to a star feeder to form a pressure seal. The star feeder which is air-sealed discharges the coal to another "smoothing-out" plate, then it joins the primary air stream flowing to the cyclone.

Features

Compare with Boiler No. 13, first Dow cyclone unit, March 1949 issue

1 — Cyclone furnaces fire crushed coal to two 400,000-lb per hr, 1250-psi, 830-F boilers

2 — Separate coal conditioning plant to stop wet coal troubles

3 — New demineralization plant, to prepare 100% makeup

4 — Centrifugal blowers, for pressurized furnaces; no I.D. fans; no dust collectors

5 — Centralized controls and instrumentation

6 — Double-extraction turbine drives 30,000-kw hydrogen-cooled generator

7 — Extensive steam and electrical distribution system

8 — Plant design to take swings

9 — Generation at 13.5 kv; air-operated 13.5 kw switchgear

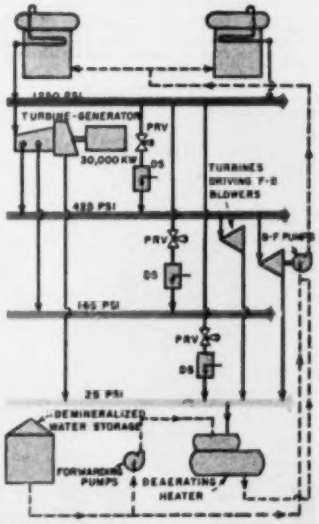


Fig. 5. Schematic diagram of main steam and water circuits of South Power Station, showing how four pressure levels are coordinated

Fig. 6. This 30,000-kw steam turbine generator is in South Power Station. In foreground, 1500-hp driving motor for one 1200-gpm boiler feed pump and 1470-hp turbine for one of two turbine-driven 1200-gpm boiler feed pumps. Right background, turbine control panel

Turbine has two extraction points, steam extracted at 425 psig and 175 psig and exhausted at 25 psig, for supplying existing plant steam systems, Fig. 5.

Generator hydrogen-cooled, 3600-rpm rated at 37,500 kva at 0.5 psig hydrogen pressure, 41,250 kva at 10 psig and 43,125 kva at 15 psig hydrogen pressure.

Reducing stations in parallel with turbine, will pass steam directly from 1250-psi header to lower-pressure system, all under full automatic control, if turbine is out of service or if, for any reason, turbine does not supply demand on any pressure system.

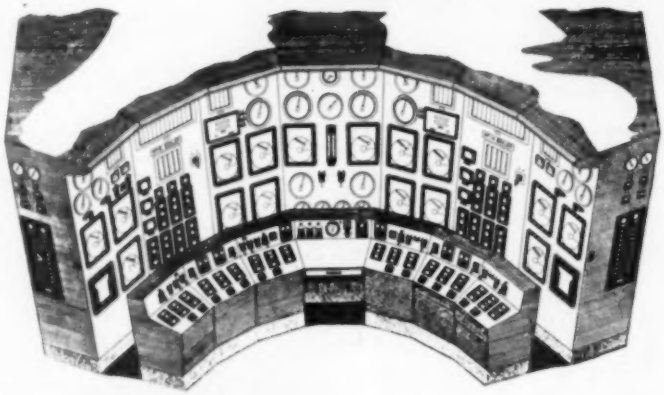
Process steam and electrical loads carried by all Dow power houses are on daily load schedules based on regular reports from the process departments and handled by power division load dispatchers just as in a utility system.

Normally turbine-driven boiler feed pumps are used; motor-driven unit is standby. Feed pumps discharge to common header through feedwater regulator valves; excess pressure regulator ahead of each feedwater regulator maintains constant differential across latter, and each turbine-driven pump has a governor position regulator. Each pump has an automatic recirculating valve on its discharge to maintain a minimum flow of 150 gpm through the pump.

Fig. 7. Central control board for two boilers and turbine has this semi-circular side with benchboard facing boilers and a traight side, shown at right rear of Fig. 6, facing turbine

Automatic combustion control maintains steam pressure, air pressure and oxygen content in furnace within predetermined limits, each cyclone being treated as a separate combustion chamber. If steam demand increases, a master steam-pressure regulator sends out air loading through a coal-air ratio relay, to the coal feed regulator, increasing the fuel supply. Loading also goes to a squaring modulator, where it is balanced against a measurement of air flow in main air duct from blowers. Thus indicated need for air is measured against volume actually flowing; any change needed to balance the two measurements creates an air pressure loading to primary and secondary air duct dampers on cyclones, adjusting them to meet the new demand.

The coal-air ratio relay setting is modified, to keep the oxygen content in the cyclone furnace at the desired value, by an electrical impulse sent by an oxygen recorder measuring the furnace oxygen. This modification changes the rate of coal feed to give the desired furnace oxygen content for best combustion.



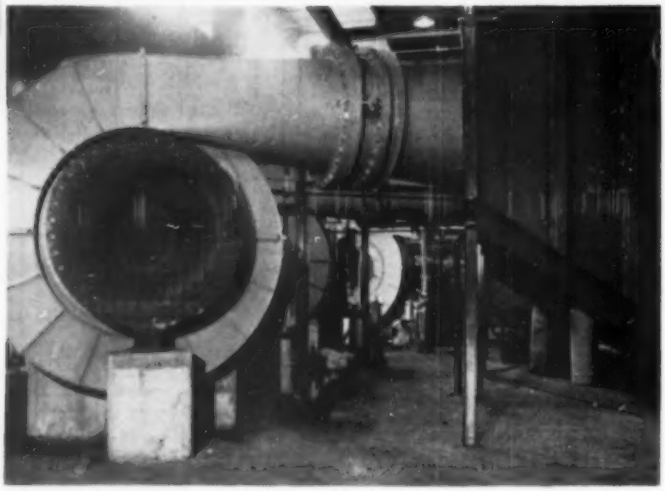


Fig. 8. Centrifugal forced-draft blowers supply all combustion air to cyclone; pressurizing entire unit; are placed right behind first air heater, see Fig. 4. Three blowers per boiler, each blower, capacity 214,000-lb air per hr at 105 F, 77 in. H_2O static pressure, 3600 rpm, single-stage single-flow. All driven by steam turbines, 425 psig throttle, 25 psig exhaust

In this main air system for each boiler, all three blowers take air directly from blower room; this air enters either from inside plant, outside plant or both. Automatic controls mix outside and boiler-room air to hold boiler room temperature constant and use minimum plant steam for unit space heaters. Control prevents more than ¼ in. vacuum in building.

Each blower discharges through a venturi to a plenum chamber, thence to air heaters. Damper following venturi is operated by a regulator measuring the venturi flow, at the same time operating the driving-turbine governors to vary speed, hence varying air discharge, the combined damper and speed control maintaining discharge pressure constant.

PRINCIPAL POWER-PLANT EQUIPMENT—SOUTH POWER STATION, Dow Chemical Co., Midland, Mich.

STEAM-GENERATING EQUIPMENT:

Boilers, 2 ..... The Babcock & Wilcox Co.
1250-psig 830-F radiant-type, with 1911 sq ft heating surface, 400,000 lb per hr. Two cyclone furnaces on each unit. Continuous-tube draining-type 8100-sq-ft superheater, 2-stage interstage submerged-drum attemperator. Continuous-tube 2-section 16,700-sq-ft economizer. Tubular 134,637-sq-ft air heater.

Forced-draft blowers, 3 per boiler ..... Ingersoll-Rand Co.
214,000 lb per hr each at 105 F, 77-in.-water sp. Single-stage single-flow 3600-rpm centrifugals.

Forced-draft-blower drive turbines ..... General Electric Co.
Two multistage, one single-stage for each boiler; 425 psig at throttle, 25-psig exhaust, 750 hp each.

Coal feeders, Boiler 14 ..... Hapman Conveyors Company, Inc.
One per cyclone burner. Flight type, 10-tph capacity, each.

Coal feeders, Boiler 15 ..... The Babcock & Wilcox Co.
One per burner, apron type, star-valve pressure seal. 10-tph each.

Soot blowers, air puff ..... Diamond Power Specialty Corp.

Water Columns ..... Diamond Power Specialty Corp.

Safety valves ..... Foster Engineering Co.

Blowoff valves ..... Manning, Maxwell & Moore, Inc.

Superheater outlet valves ..... Crane Co.

Feedwater-inlet valves ..... Edward Valves, Inc.

Combustion-control system, air operated ..... Republic Flow Meters Co.

Forced-draft blower control ..... Republic Flow Meters Co.

Superheat control ..... Bailey Meter Co.

Coal scales ..... Richardson Scale Co.

Coal valves ..... Stock Equipment Co.

Ash-removal system, hydraulic ..... Allen-Sherman-Hoff Co.

TURBINE GENERATOR:

Turbine generator, one ..... Westinghouse Electric Corp.
1250-psig 830-F throttle steam, 425- and 165-psig extraction, 25-psig exhaust. 30,000-kw 0.8-pf 13,800-v 3-phase 60-cycle 3600-rpm generator hydrogen cooled. 150-kw direct-connected main exciter, 2.5-kw direct-connected pilot exciter. 6140-sq-ft 2-pass hydrogen cooler, 455-sq-ft 8-pass exciter air cooler.

Exciter air filter, 3-section ..... American Air Filter Co., Inc.

Oil coolers, two, 500 sq ft each ..... Westinghouse Electric Corp.

FEEDWATER EQUIPMENT:

Boiler-feed pumps, 3 ..... DeLaval Steam Turbine Co.
6-stage single-suction volute-type solid-case 1200-gpm 3570-rpm centrifugals rated at 1554-psi net pressure. Two driven by 7-stage steam turbines, 425-psig throttle pressure. 25-psig exhaust, 1470 hp. One driven by 1500-hp 2300-v 3-phase 60-cycle motor.

Turbine-driven feed-pump control ..... Republic Flow Meters Co.

Motor-driven feed-pump discharge valve ..... Republic Flow Meters Co.

Feed-pump recirculating valves ..... Republic Flow Meters Co.

Deaerating heater, atomizing type ..... Cochrane Corp.
950,000 lb per hr, 267 F, 25-psig steam. Two 150-sq-ft vent condensers, 25,000-gal storage tank.

Heater water-level control valve ..... Fisher Governor Corp.

Heater relief valve, multiport ..... Cochrane Corp.

Feedwater regulator ..... Northern Equipment Co.

Excess-pressure regulator ..... Republic Flow Meters Co.

Continuous-blowdown exchanger, flash tank ..... Cochrane Corp.

Heater level indicator ..... Reliance Gauge Column Co.

COAL-HANDLING AND PREPARATION EQUIPMENT:

Locomotive, 50 tons, fireless ..... H. K. Porter Co., Inc.

Gas burners in car-thawing pits ..... Maxon Premix Burner Co.

Coal-car shakeout ..... Hewitt-Robins, Inc.

Conveyors and feeders ..... Link-Belt Co.
200-tph from track hopper to silos, 80-tph silos to bunkers

Breakers and crusher ..... Pennsylvania Crusher Co.

Dryer and screens ..... Link-Belt Co.

Dryer dust collector ..... Aerotec Co.

Dryer furnace, 70,000 cfm at 700 F ..... Furnace Economy Co.

Spreader stoker for dryer furnace ..... American Engineering Co.

Dryer inlet and exhaust fans ..... Clarage Fan Co.
Inlet: 70,000 cfm, 700 F, 6-in. sp, 150-hp motor
Exhaust: 45,350 cfm, 210 F, 5-in. sp, 75-hp motor

Dryer-furnace control ..... Brown Instrument Co.

Conveyor dust collector ..... American Air Filter Co.

Weightometer ..... Merrick Scale Mfg. Co.

Coal silos, two 36-ft dia, 60 ft high ..... Neff & Fry Co.

Ventilators ..... Swartwout Co.

PIPING, VALVES AND INSULATION:

High-pressure piping ..... M. W. Kellogg Co.

Reducing valves and desuperheaters ..... Republic Flow Meters Co.

Gate and globe valves ..... Crane Co.

Small h-p valves ..... Crane; Edward; Manning, Maxwell & Moore

Service-water control valves ..... Fisher Governor Co.

Safety valves ..... Farris Engineering Co.

Relief valves ..... Atwood & Morrill Co.

Miscellaneous valves ..... Crane Co.; Lunkenheimer Co.

Air reducing valves ..... Leslie Co.

High-temperature pipe insulation ..... Union Asbestos & Rubber Co.

Low-temperature pipe insulation ..... Johns Manville

Cork insulation ..... Jackson Insulating Co.

Steam traps ..... Strong, Carlisle & Hammond Co.

METERS AND INSTRUMENTS:

Draft gages ..... Hays Corp.

Flow meters ..... Bailey Meter Co.; Foxboro Co.; Republic Flow Meters Co.

Indicating-pressure gages ..... Manning, Maxwell & Moore, Inc.

Pressure recorders ..... Bailey Meter Co.

Indicating thermometers ..... Manning, Maxwell & Moore, Inc.; Taylor Instrument Cos.

Temperature recorders ..... Bailey Meter Co.; Leeds & Northrup Co.

Hydrogen recorders ..... Cambridge Instrument Co.

Liquid-level recorder ..... Foxboro Co.

Conductivity, oxygen, pH, water-level recorders ..... Bailey Meter Co.

Annunciators ..... Edwards & Co.

Speed indicators ..... General Electric Co.; Metron Instrument Co.

Ammeters ..... Weston Electrical Instrument Corp.

Wattmeter ..... Leeds & Northrup Co.

Level switches ..... Fuller Co.; Bender Warwick Controller Co.

Instrument panels ..... Falstrom Co.

ELECTRICAL EQUIPMENT:

13.8-kv switchgear ..... General Electric Co.
15-kv cubicle, 2000-amp, 1,500,000-kva, air operated. Two main sections, synchronizing bus and transfer bus. One generator circuit, 37,500 kva; 6 feeder circuits, 1200 amp; one transformer circuit for two 5000/6667-kva 3-phase banks; one synchronizing bus-tie circuit, 2000 amp; one transfer bus-tie circuit, 2000 amp.

Switchgear, air compressors, 3 ..... General Electric Co.
350 psig, 9 cfm with 17 cf storage receivers; 3 extra receivers.

Synchronizing reactors ..... General Electric Co.
Three 13.8-kv 2000-amp single-phase, 6%.

Generator circuit breakers ..... General Electric Co.
Neutral-breaker: 15-kv metal-clad, 1200 amp, 500,000 kva. Neutral grounding resistor: 8000-v 2000-amp 4.0-ohm, one minute, metal enclosed. Field breaker: metal-enclosed drawout air circuit breaker, 250-v dc, 800 amp.

Generator voltage regulator ..... General Electric Co.
One indirect-acting with auxiliary motor-driven exciter rheostat.

General surge-protective equipment ..... General Electric Co.
One metal-enclosed equipment containing 3 station-type lightning arrestors and 3 capacitors.

Generator bus ..... General Electric Co.
2000-amp 3-phase 15-kv metal-enclosed bus about 90 ft long.

Station switchboard ..... General Electric Co.
Sectionalized duplex control switchboard with two swinging brackets.

Station-service switchgear, 2300 v ..... General Electric Co.
5-kv metal-clad with 1200-amp 150,000-kva breakers. Two sections, 9 units each section, tie between sections.

Station power switchgear, 440 v ..... Westinghouse Electric Corp.

Station-service transformers, 13.8/2.3 kv ..... General Electric Co.
Two 5000/6667-kva self or forced-air cooled, 3-phase delta-delta.

Station-power transformers, 2300/440 ..... Westinghouse Electric Corp.
One 1500 and one 750-kva, air-cooled, 3-phase, delta-delta.

Station battery ..... Electric Storage Battery Co.
One 60-cell 125-v pasted-plate type sealed in glass jar. 330 amp for one minute down to 1.75 v per cell.

Battery-charging equipment ..... General Electric Co.
Cubicle with phanotron charger; 125 v, 12.5 amp, 115/230 v, ac.

Power cables, 3-conductor, 15-kv ..... General Electric Co.
VC, Flamenol jacket, bronze interlocked armor, aerial type.

Motors ..... Elliott Co., General Electric Co. Reliance Electric & Engrg. Co., Westinghouse Electric Corp.

OTHER EQUIPMENT:

Sluice-water pumps, 2 ..... Worthington Pump & Machinery Corp.
2200-gpm, 265-ft discharge head, 4-stage, vertical turbine-type 200-hp, 1800-rpm 2300-v 3-phase 60-cycle motors.

Forwarding pumps, 2 ..... Ingersoll-Rand Co.
2000-gpm 230-ft total head, single-stage double-suction centrifugal volute, 150-hp 1750-rpm 2300-v 3-phase 60-cycle motor.

Cooling-water pumps, 2 ..... American-Marsh Pumps, Inc.
1000 gpm, 100-ft head, single-stage double-suction centrifugal. 40-hp 1750-rpm 440-v 3-phase 60-cycle motor.

Cooling-water return pumps, 2 ..... American-Marsh Pumps, Inc.
750-gpm 80-ft head, single-stage double-suction centrifugal. 20-hp 1750-rpm 440-v 3-phase 60-cycle motor.

Locomotive water pump ..... Ingersoll-Rand Co.
20-gpm 225-psig discharge head, 4-stage single-suction opposed impeller centrifugal. 10-hp 3450-rpm 440-v 3-ph 60-cyc motor.

Chemical feed pumps, 3 ..... Milton Roy Co.

Sump pumps ..... Weil Pump Co.

Condensation-return unit ..... American-Marsh Pumps, Inc.

Soot-blower air compressor ..... Ingersoll-Rand Co.
790 cfm 500-psig discharge 3-stage reciprocating, 300-hp 360-rpm 2300-v 3-phase 60-cycle synchronous motor.

Plant air compressor ..... Fuller Co.
1590-cfm 100-psig discharge 2-stage rotary. 350-hp 575-rpm 2300-v 3-phase 60-cycle motor.

Intake filter, soot-blower compressor ..... American Air Filter Co.

Aftercooler, plant compressor ..... Pennsylvania Pump & Compressor Co.

Air receivers ..... Edgemoor Iron Works

Water tank, 40-ft dia, 70 ft high ..... Chicago Bridge & Iron Co.

Dust hopper and breeching ..... Connery Construction Co.

Masonry stack ..... Alphons Custodis Chimney Construction Co.

Coal bunkers ..... Fort Pitt Iron Works

Turbine-room crane, 75-ton ..... Whiting Corp.

Receiving-room crane, 5-ton ..... Robbins & Myers, Inc.

Compressor-room hoist, 6-ton ..... Yale & Towne Mfg. Co.

Blower-room crane, 40-ton ..... Whiting Corp.

Blower-room hoist, 10-ton ..... Yale & Towne Mfg. Co.

Dust collector, coal bunkers ..... American Air Filter Co.

Combustion-air-intake-filters operator ..... Johnson Service Co.

Combustion-air heaters ..... Trane Co.

Oil purifiers ..... DeLaval Separator Co.

Instrument-air dehydrator ..... Davison Chemical Co.

GENERAL CONSTRUCTION:

Design engineers ..... Dow Chemical Co.

General contractor ..... Austin Co.

Building piling ..... Raymond Concrete Pile Co.

Elevator ..... Detroit Elevator Co.

Steel sash ..... Truscon Steel Co.

Heaters ..... Trane Co.; L. J. Wing Mfg. Co.

Temperature controllers ..... Fulton Syphon Co.; Johnson Service Co.

Meeting *Technological and Economic* Changes

A review of the experiences of an engineer, who, in 25 years of consulting practice, learned to adapt his knowledge towards meeting the technological and economic changes in industry; how the interest taken and assistance given by technical editors helped him become a consulting engineer. It describes the changes in practice to meet technological changes and includes a discussion on the development of equipment for burning various fuels. Questions of investment, incentive plans, care and maintenance are also considered

By ZUCE KOGAN
Consulting Engineer, Chicago, Illinois

TWENTY-FIVE years is a considerable span of time in terms of human life and it can mean many things to different people, depending upon their individual experiences and the circumstances under which they have lived. To an engineer who has spent the last 25 years as a consultant in the field of combustion and the industrial application of heat and power, this quarter of a century represents a period of great technological and economic change.

These 25 years of consulting experience had their origin some 5 years earlier, when I got my first job as a young draftsman in a French sugar refinery in Kom-Ombo, Egypt, on the Nile River about 400 miles south of Cairo. This was called La Sucrerie et Rafinerie d'Egypt.

In an endeavor to do something more interesting than routine drafting involving the use of text books and handbooks as thinking media, I used to walk through the hot, tropical Kom-Ombo factory, looking for a problem. Here I came up against my first case involving the effect of technological change upon the process of combustion. This had to do with the introduction of a process in sugar manufacturing called imbibition—the wetting of the sugar cane after the juice has been pressed out so that the water will absorb and dissolve sugar juice adhering to the cane. Since the sugar cane refuse —bagasse—is used as fuel, the introduction of this wetting process presented a difficult problem in combustion. In these years, around 1920, the bagasse fuel contained from 60 to 75 per cent moisture.

In questioning various departmental foremen in the plant the most interesting and stirring reaction I had was from an illiterate fireman who complained that burning bagasse was like throwing a bucketful of fuel into the furnace and then drenching it with a bucketful of water. He said that I could see for myself that the bagasse was smouldering, not burning, yet his chief, the plant engineer, was under the erroneous impression that burning a combination of bagasse and oil fuel at the same time would produce more steam than in burning oil only.

Fig. 1. Zuce Kogan, the author of this article, at his desk

When I dug into available data and tried to gather further information on the subject, I was ridiculed by the husky French Chief Engineer and the French Chief Chemist. France, before the advance of technological development in Germany, was noted for its engineering skill. With its colonies in tropical Africa, France became master of sugar cane technology and these Frenchmen with whom I had contact felt that only they could solve engineering problems relating to sugar manufacture and, therefore, I was wasting my time. Despite their derision, I still continued to collect data and make studies. I ignored their ridicule of my theories, suggestions and arguments, and proceeded with the limited tests I was allowed to conduct outside the regular working hours. The subject was of great interest to me, and though I was unable to put what I learned into practice, I learned much. Also I formed definite opinions concerning the design of furnaces and combustion.

Some years later, while visiting relatives in Montreal, Canada, I took

some courses at the University of Montreal, and it was at that time that I worked up courage to write a series of articles concerning my experiences and theories on the burning of bagasse and submitted them to both French and English technical journals. My English was bad and it was difficult, often, to find proper words to express myself. These articles were accepted, however, the American editors polishing up my grammar.

A few of the old-time readers may remember some of these articles in *Power Plant Engineering* in 1922 to 1923. They dealt with a variety of factors concerning theories of combustion and design of furnaces for burning bagasse and other high moisture content fuels.[1]

To my surprise and astonishment, the publishers received inquiries concerning my work in burning bagasse, asking for additional information and help in the solution of problems in this field. At the same time, other publications in the United States asked me to write on the subject for them.

The enthusiasm of these readers for further information made me desirous of going to the United States but I found that I could not get a visa to enter the country. This was disappointing and when I informed the editors of *Power Plant Engineering* that I might have to go back to Egypt, they wrote me that they regretted this since, in their opinion, I would be a valuable contributor to American engineering practice.

Fortified by this opinion of the editors of a leading engineering journal, I took the letter to a lawyer who, in turn, took it to the Immigration Office. It was on the basis of this letter, that the authorities finally granted my visa and I proceeded to Chicago.

Once in the U.S. I was confronted with the problem of getting a job somewhere or accepting requests to design bagasse burning furnaces. I was only 24 years old, a newcomer in a strange country, and I was hesitant to embark on a consulting career in which I had very little experience. So I went to the editors of *Power Plant Engineering* who had published my articles. Mr. A. L. Rice, the Editor at that time, gave me encouragement; he made me understand that under ordinary circumstances an engineer might open

[1] The titles of eight articles published in *Power Plant Engineering* between 1922 and 1923 are as follows:
1. Theory and Design of Furnace Stokeholes. Dec. 15, 1922
2. Draft Essential to Use of Moist Fuel. Jan. 15, 1923
3. Moist Fuel Presents Ash Handling Difficulties. Feb. 1, 1923
4. Furnace Design for Effective Drying. Mar. 1, 1923
5. Boiler Setting for Economical Steaming. Apr. 1, 1923
6. Drying Moist Fuel Outside the Furnace. June 15, 1923
7. General Factors Governing Design of Arches. Sept. 15, 1923
8. Grates for Moist Fuel. Oct. 15, 1922

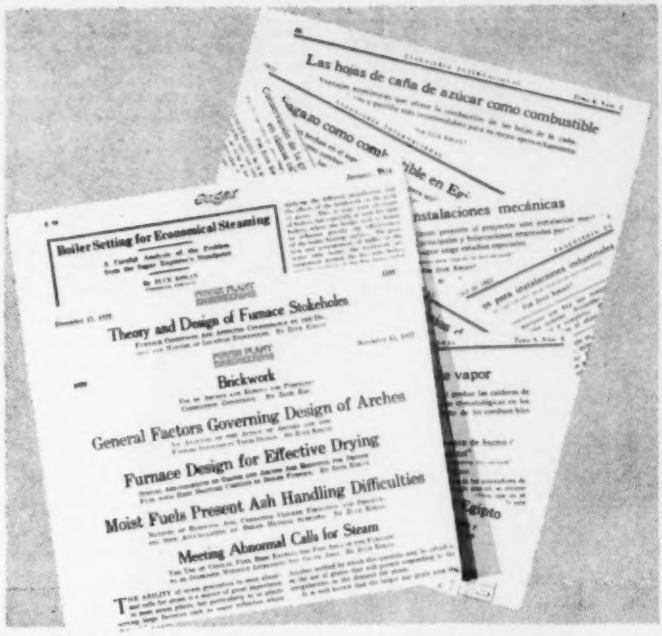

Las hojas de caña de azúcar como combustible
Boiler Setting for Economical Steaming
Theory and Design of Furnace Stokeholes
Brickwork
General Factors Governing Design of Arches
Furnace Design for Effective Drying
Moist Fuels Present Ash Handling Difficulties
Meeting Abnormal Calls for Steam
instalaciones mecánicas
vapor

Fig. 2. Headings of various articles which the author wrote for technical magazines and which led to requests for help in the design of furnaces and associated equipment

a consulting office and often have to wait years before landing his first assignment, whereas in my case, with actual requests for my services, opportunity was knocking at my door. This was all I needed; I took his advice and that was the beginning of a long, interesting, and fruitful consulting practice.

Adapting Myself to a Coal-burning Economy

When an engineer moves from one country to another he often finds a different kind of economic condition. In Egypt, which is located closer to large oil fields than to coal fields, and where sugar cane grows in abundance, the oil is the economical fuel and bagasse, the sugar cane refuse, a by-product which must be got rid of. Upon arriving in Chicago in 1924 I found that the proximity of the coal fields made coal the economic fuel at that time. This is no longer strictly true as discussed later in this article. Under this condition, my knowledge of the burning of oil and bagasse was of little use.

To adjust myself to the burning of coal, therefore, I spent considerable time in the technical libraries of Chicago collecting and organizing data on coal, coal burning and factors affecting the economical use of this fuel. After some six months of study, I called on a laundry and asked the owner to let me make a survey on their steam plant. The owner was skeptical, and after looking over my articles and references on burning fuel oil and bagasse, remarked sarcastically that if the Commonwealth Edison Company were to use my services, he would too.

He was scoffing of course, but his comments served as a goad. I went to the Commonwealth Edison Company. They suggested that I try their subsidiary, the Illinois Maintenance Company, with offices in the same building, which generated steam (for central heating service) instead of electricity, and therefore, was operating in fields more in line with my work. This, I did. The assistant vice-president, a well known engineer, explained that they had on their staff, consulting engineers, efficiency engineers, and operating engineers, and that my services would not be of much value to them particularly since I had no American experience and no experience in burning coal.

I did not give up, however. I first asked for some test data, and then for permission to visit one of their plants and the chance to submit a report, on my own time, on American practice. After showing me some of their performance charts, I gave them reasons why charts do not tell the entire story. This seemed to make sense, and so permission was granted me to survey the main plant. I then found that my studies on coal burning were not enough. This plant was burning coke breeze, the very cheapest fuel—actually a by-product of coal coking. So I did more studying and in something less than three months I submitted a re-

POWER PLANT ENGINEERING

Chicago

December 12, 1928.

Dear Sir:

Fig. 3. Copy of an early letter from one of the editors of Power Plant Engineering which led to the establishment of Mr. Kogan as a consulting engineer in Chicago

port, entitled, "The Effect of Chain-grate Stoker Speed on Burning Coke Breeze."

The assistant vice-president was impressed with the report but he felt that it was too academic, and in discussing it, he gave me the most helpful advice that anyone could have given me and that was to interpret my studies *in terms of dollars and cents*. He then offered to engage my services if I would stick to that rule. This, I promised but asked that I be permitted to work on a part-time basis at least at the beginning unil I could complete some work I had contracted for designing bagasse furnaces for Central and South America. After three years I had to leave this company because by that time I had more consulting work than I could handle.

Cost Reduction Without Expenditures

The lesson I had learned—interpret engineering studies in terms of dollars and cents—defined my goal and objective in all of my work. It made me search for savings, including savings that could be made without additional investment. The subtitle of an article describing one of my experiences in 1926 was, "New Equipment? Yes, but first be sure you are operating your old plant at its maximum efficiency."

My first case involving savings without investment was actually a challenge, when in the early part of 1926, an elderly Scotsman, president of a chocolate company, expressed himself somewhat as follows: "Young man, I am Scotch and I have no intention of spending money on new equipment. If you can reduce my costs without expenditure I can use you."

I accepted the challange and went him one better, answering, "I will make my goal one step harder—I will work on the basis of no expenditures at all for repair, maintenance, redesign or the like but will confine my improvement entirely to methods of operation and attendance." He was not convinced that I could do that but gave pleasant approval.

In the boiler room of his plant were three Kroeschell watertube boilers equipped with chain grate stokers. Two conditions I had counted on did not exist. One was that the boilers would be operating at very low efficiency. The efficiency, however, I found, was fairly good. The second was that the load would be of a fluctuating character. It did not fluctuate very much, however, because they had a steam engine that generated electric power and that load equalized the boiler load to a great extent.

In my disappointment on not finding these common faults in operation I came near giving up the Scotman's challenge, when it dawned on me that when more than one boiler is in operation, there is a problem of economical load distribution among the boilers. So I studied the varying boiler efficiencies under changing loads and worked out a crude load distribtuion chart.[2] It is not the purpose here to describe in detail the methods I used but as a result of adopting the load distribution I recommended, a saving of from two to four tons of coal per day was achieved. The Scotsman was skeptical and wanted proof, so he ran alternate tests for a couple of weeks. When he was convinced that the savings were there he asked me to work out savings in fuel costs with investment in major improvements. After redesigning the boiler furnaces, the fuel bill in this plant was reduced by $8000 per year, which was about one-third of the total yearly fuel bill.

[2] I have since perfected the load distribution chart and one of my later charts was published in connection with the article, "Economical Boiler Load Distribution," *Power Plant Engineering*, Page 620, Oct. 1937.

Fig. 4. The technical Library in the Kogan organization. This library is unique in that it consists largely of clippings from about 20 technical magazines, engineering society journals, and bulletins from research organizations. These are filed in loose leaf binders, one or more binders to each subject. Even a relatively well-known subject like Boiler Blowdown has its own binder and consists of over a thousand pages. There are separate bookcases for each subject, one dealing with coal, another with stokers, others with coal and ash handling, etc.

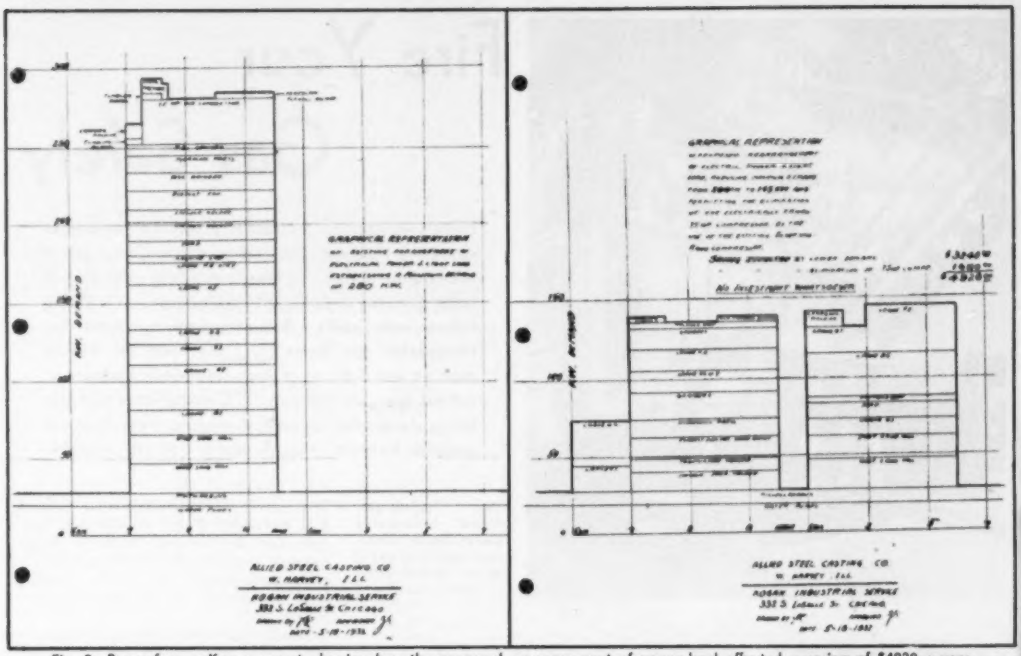


Fig. 5. Pages from a Kogan report, showing how the proposed rearrangement of power load effected a saving of $4920 a year

Economics of Standardization

Progress in the art of management led to the development and application of standardization. It was at first limited to industrial and manufacturing application and then slowly entered many other fields including the heating field.

When a company owning the largest chain of movie theatres in Chicago engaged my services, I demonstrated a saving by changing the practice of firing a boiler equipped with a Burke Dutch-oven stoker.[3] By zoning the stoker and working out a set of instructions for regulating the air supply to each zone, they reduced the fuel consumption by 25 per cent. Having placed my services on a retainer basis for all their theatres, I found it advisable first to standardize the practices of operating similar equipment, then to use standard specifications for coal, and later to standardize on equipment and supplies for the heating, power and air conditioning installations.

In the meantime, this large Chicago chain of theatres merged with still a larger national one and in March 1927 I received a letter of invitation and a programme entitled "Preliminary Schedule of the Meeting of the Standardization Committee—" indicating at which sessions I was to be present. My subject was "that standardization has its limitation in wide spread localities." It pointed out that equipment chosen must first be considered from point of view of obtaining parts and service. Equipment manufactured in Chicago or represented by a Chicago firm that carries parts may not have such facilites in other sections of the country. For this reason standardization of equipment should be limited to localities.

[3] In 1925 and 1930 the Dutch oven was as popular as the underfeed stoker is today.

Burning Cheaper Coal Through Incentive Plan

In our economy when there is a business boom, labor gets scarce and the output per man hour is reduced. This in turn has an effect to increase the cost of supplies such as coal, oil fuel, maintenance, parts, etc. Cost engineers still have fresh memories of 1945-48 experiences with reduced man-hour output and increased cost of supplies with the reversal of this tendency in 1949.

The years 1945-1948 were a boom of scarcity while the boom of 1929 was a boom of competition. To meet competition manufacturers' prices had to be kept low and therefore the reduction in man hour output and increase in cost of supplies was considerably less pronounced. Regardless of the extent of rise in cost of supplies, a rise in cost awakens price consciousness on the part of the manufacturer and discussions on economics lead to the consideration of cheaper coal.

The trouble with the use of cheaper coal is that it imposes more of a human problem than an engineering problem, particularly in smaller plants where the coal consumption is too small to warrant expensive coal burning, coal and ash handling equipment, etc. With cheaper coal there is always more ash and clinkers to handle, more slag sticking to the furnace walls; consequently more alertness is required to keep the fires going to prevent losing the steam pressure. Use of cheap coal requires more watching and worrying about smoke to avoid getting a ticket from the city smoke department, a thing an operating engineer and fireman consider a black mark on their reputation. It also makes necessary explanations to the management, which objects to being fined. In these cases where poor coal was burned, as the consulting engineer I would facilitate things considerably within the limited allowance for expenditure, by inexpensive improvements of the furnace, air supply, smoke abating devices, but still the burden for the operating engineer and fireman was considerably heavier than with good grade coal.

I noted that a quick change from a high grade of coal to a cheaper one imposed too much of a shock, and I started first to mix higher grade coal with cheaper coal, but then when it came to burning the cheaper coal in large enough percentage, the complaints were hard to take.

There were two solutions to the problem, one to spend considerable money on automatic and expensive equipment, the other to use incen-

(Continued on page 114)

Fire Your Gas Safely

There's no need for accidents if you use the proper operating methods and safeguards in firing gas in your power boilers . . . New gas safety control cock helps prevent lighting-off explosions . . . Flame failure safeguards, flame-conductivity type for transparent gas flame . . . Gas and air mixture must be just right, as in your automobile carburetor, not too lean, not too rich . . . Combustibles recorder being developed to control mixture from flue gas analysis; however, this device is not yet available

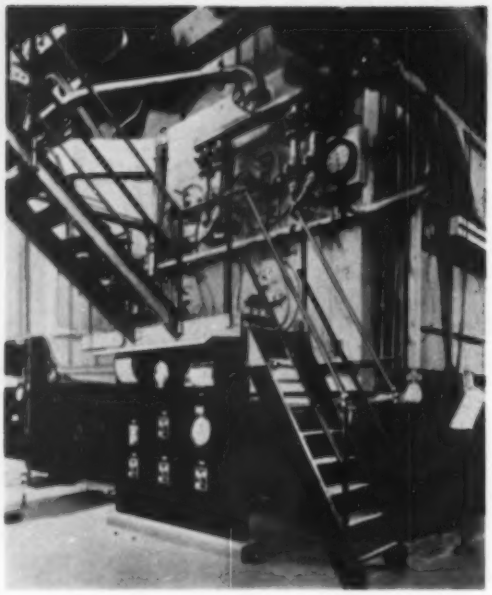


Fig. 1. Typical gas-fired industrial power boiler, showing gas burners, boiler control panel and accessories

IN THE SOUTHWEST, where natural gas is readily available, many power boilers have been fired with gas for many years. Now gas fuel for power boilers is becoming increasingly available in many Northern parts of the country because of the extension of natural gas pipe lines during the past few years. As a result many industrial and utility power plants nowadays consider conversion of existing boilers to gas firing or use of gas as base fuel on new units, with appropriate oil or coal standby. Methods of making technical and economic comparisons between the three fuels and of designing equipment for them are now well established. This article deals only with the problems of burning gas with safety once you have decided, for one reason or another, to burn it in your boilers.

Considerable progress has been made toward solving problems connected with the prevention of fuel explosions in large gas-fired boiler furnaces having manual ignition and constant attendance.

Explosions are infrequent but their consequences can be very serious. Boilers are costly, vitally important to production, and all reasonable measures are justified to assure their uninterrupted operation. These are reviewed in a recent issue of *Factory Mutual Record*.

Careful, competent operation is of first importance in preventing an explosion, but even the most capable operator may err occasionally, and especially during the stress of an emergency. The purpose of available automatic safety controls is to prevent a hazard from developing at such times, by (1) sounding an alarm, (2) preventing unsafe short cuts in procedure, or (3) quickly shutting off fuel.

Lighting-Off Explosions

Recently, at a chemical plant, an explosion put a 100,000-lb-per-hr high pressure boiler out of commission. Failure of the compressed air for actuating controls had automatically shut off the gas supply. Following normal procedure, an attendant supposedly closed the cocks at each of the four burners, and then closed the manually-operated main gas valve. Actually he left one cock half open. This set the stage for the explosion.

When the main valve was reopened to start the boiler again, unburned gas flowed through the partly-open cock into the furnace. Then, when a lighting torch was inserted, the gas-air mixture exploded. The water-tube walls were bulged 4 ft outward. Plant production was curtailed for several months while repairs were made. Fortunately no one was injured. In a similar explosion at another plant the operator was killed.

Accidents from this cause can be practically eliminated by using gas safety control systems developed by the Factory Mutual Laboratories, and described in the *Record*. The system, shown in Fig. 2, assures that all burner cocks are tightly closed before the main gas valve can be opened.

A new type of safety control cock has been developed and is now commercially available, which replaces the ordinary burner cock. This cock has side ports; and the side ports of all cocks are connected with copper tubing. One end of the line of tubing is connected to the main gas line on the supply side; the other to a checking pressure switch.

How the Safety System Operates

On lighting-off, the operator first turns gas into the small line connecting the cock side ports. If the cocks are fully closed as they should be, gas flows through the cocks by way of the side ports and operates

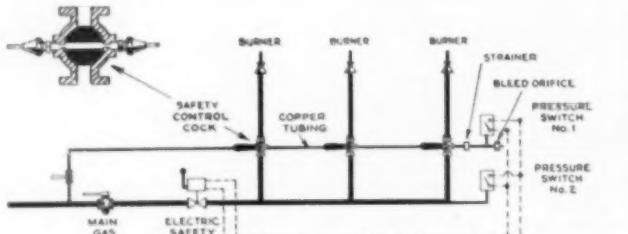


Fig. 2. Gas safety control system for power boilers, showing construction of control cock. Gas cocks on each burner control a pressure switch, which in turn controls the electric valve.

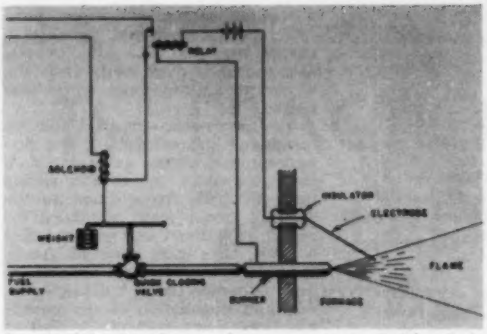


Fig. 3. Schematic diagram showing operating principle of the electrode or flame-conductivity type of flame failure control for gas firing

the checking pressure switch. This in turn energizes the electric valve on the main gas line, so the operator can open it, which must be done by hand.

If one of the cocks happens to be even partly open, the checking pressure switch will not operate and the electric valve cannot be opened.

The system is adaptable to any type of burner and its air-gas mixing equipment. Combustion air, where available, is preferable to gas for use in the safety system. Protection is provided against failure of combustion air or gas pressure, while firing. Other advantages, such as simplicity and reliability, also recommend the system for use in important installations.

Flame Failure Explosions

Explosions of another type can occur when burner flames go out and gas pours into the furnace. Normally the hot furnace will relight the gas instantly and without harm, but at low firing rates, the gas may collect and form an explosive mixture. Recently an inexperienced operator failed to adjust the draft properly, and a sudden increase in air velocity blew the flame away from the burner and extinguished it. An explosion followed, which blew off the top and side casings of the boiler and bent the tubes and supports.

Even the most alert operator, in many cases of this kind, cannot shut off the fuel quickly enough to avert an explosion; but automatic devices known as combustion safeguards are designed to do it in a few seconds. They are widely used on many types of smaller gas and oil-fired industrial equipment.

Two types of combustion safeguards are applicable to large boilers. Their principles and operation were explained in detail in an article What the Power Engineer Needs to Know About Flame Failure Protection, *Power Generation*, February 1948, from which Fig. 3 is taken.

Those of the photo-electric type cannot yet reliably detect flame failure at gas burners because the gas flame is transparent. They are well adapted for oil burners, which have luminous flames.

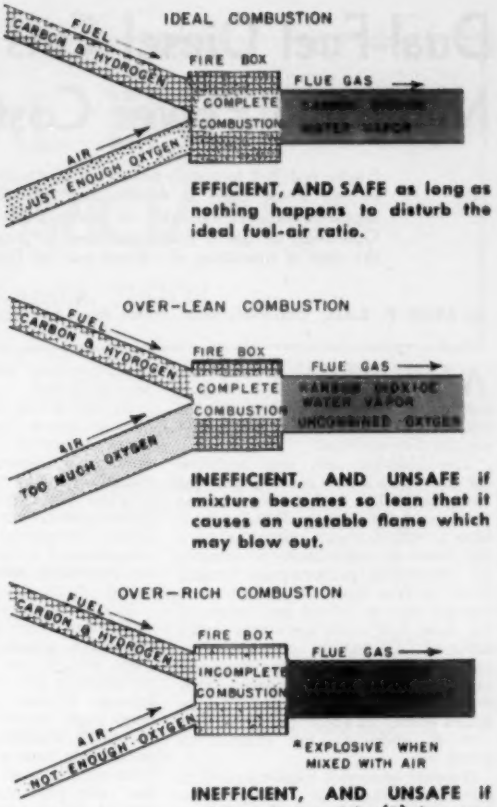


Fig. 4. Diagram showing safe and unsafe combustion conditions in firing gas in power boilers

Flame - conductivity combustion safeguards, Fig. 3, are the only type so far practical for large gas-fired boilers. Yet even these have not always proved satisfactory. Flame electrodes have burned off or sagged out of position, and burner flames have momentarily moved away from the electrodes, causing repeated false shutdowns. Rather than risk such occasional loss of power, most plants have operated their boilers without combustion safeguards, and the result has been a number of flame-failure explosions.

Several years ago, as part of a special study, Factory Mutual engineers visited 14 plants and analyzed the performance of combustion safeguards at large gas-fired boiler installations. Four different types of burners were involved. Manufacturers of boilers and controls cooperated in the study.

It was found that for best results the flame-conductivity safeguard must depend on a strong pilot flame contacting the electrode in the path of the main burner flame. When the safeguard is first installed it should be arranged to sound an alarm. After operation is found to be reliable, it should be arranged also to shut off the gas. Make periodic operating tests of the device and frequent checks of electrodes, which should be cleaned, adjusted, or replaced as needed. Vacuum tubes in the device also require periodic replacement. Results to date show that these safeguards can give satisfactory protection *if the devices are correctly installed and carefully maintained.*

Explosions with Burners Firing

The possibilities of still another type of explosion, which can occur from over-rich combustion while burners are still firing, became apparent from the investigation, see Fig. 4. If, due to faulty control of gas-air ratios, too little oxygen is admitted to burn the fuel completely, hydrogen, carbon monoxide and sometimes uncombined carbon will accumulate in the furnace, passes and stack. These flammable

(Continued on page 124)

Dual-Fuel Diesel Cuts Municipal Power Costs

Engine installed to supply power during construction of new steam plant at Ames, Iowa, now used as supplementary power unit to carry peak loads. Operating on gas it produces power at one third the cost of operation on 10-cent-per-gal Diesel oil

By **ARCH P. BALL**, Superintendent, Ames, Iowa, Municipal Power Plant

A SUPPLEMENTAL dual-fuel, supercharged diesel engine generator unit is giving notable economies in the Ames, Iowa, Municipal Power Plant.

The 1440-hp unit was installed for use while a new steam plant was being built. The coal strike and conversion of the plant's 2000-kw turbine to 425-lb steam operation gave the diesel an opportunity to compile an impressive performance record. Since it has been possible to use natural gas as diesel fuel most of the time, fuel costs were materially reduced. Operation on 1000-Btu natural gas at 20.5 cents per thousand cubic feet, as compared with diesel oil at 10 cents per gallon, produced power at about one-third the cost of operating the engine on diesel oil.

Another economic consideration in the installation of the diesel-powered unit was the fact that it can be used during the daily peak load periods while larger steam generating units would be base loaded. This is ideal because it avoids the necessity of putting another boiler on the line for short periods daily. Sporadic boiler operation increases both labor and fuel costs.

Extensive use of the diesel-powered unit since its installation has also demonstrated its economy over the plant's steam turbine equipment—two 3000-kw, and one 2000-kw turbine generators.

The Ames plant was built in 1896. Its first generating unit was powered by a 160-hp reciprocating steam engine. During the first four or five years of operation, the plant was run only at night—to take care of the town's small residential lighting requirements. Even after 24-hour operation was started, the plant was not run during daylight hours on Sundays until about 1911. Expansion has been necessary many times. Six generating units and eight boilers have served their usefulness and been discarded since the plant was opened.

An indication of the load growth is seen in the annual per capita consumption of electric energy in the City of Ames during the last 35 years. In 1911 the per capita consumption was 105 kwh. In 1946 it was 1,270 kwh.

In 1947 it was evident that expansion of generating facilities would be necessary to meet the increasing demand for electric energy. Previous expansion plans had resulted in the original plant structure being enlarged several times. With each addition, considerable difficulty was encountered in housing the massive equipment in the limited available space.

In view of space limitations, it was decided to erect a new steam plant on a site adjacent to the existing plant and to use both plants until the existing one had outlived its usefulness. Ordinarily it would have been most feasible and economical to purchase additional power from an outside source during the two-year construction period. However, the only practical source of purchased supply, was also restricted by limited capacity.

It was under these conditions that the plan was adopted for purchasing a diesel engine generator unit. The unit would not only furnish a supplemental source of power until 1950, but also would provide a means, after that time, to accommodate the daily peak loads while the larger generating units were base loaded.

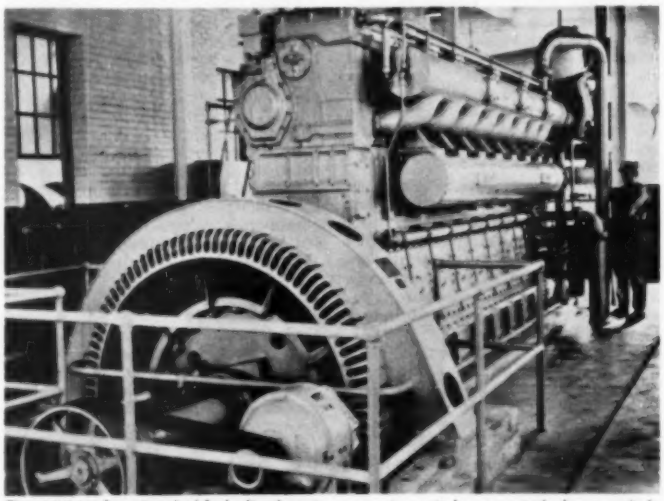
Contracts were awarded for the furnishing and erection of one Superior diesel engine generator unit, plus auxiliaries, piping and wiring early in 1948. An addition to the existing steam plant structure for housing the diesel unit was awarded to Ben Cole and Sons of Ames, Iowa.

Construction of the building addition and installation of the equipment was completed in the Fall of 1948. Since that time the unit has been used to assist in carrying daily peak loads and has been run extensively while the 2,000-kw turbine was converted to 425 psi operation, which is the operating pressure of the other existing turbines.

The 1440-hp diesel engine manufactured by Superior Engine Division of The National Supply Co., is directly connected to a 1000-kw, General Electric alternator with belt driven exciter. The engine is a four-stroke cycle, eight cylinders, supercharged, dual-fuel unit operating at 360 rpm. Pistons in the 14½ x 20 in. cylinders are oil cooled.

Auxiliary Equipment consists of:

Oil Filter	Hilliard Corporation
Oil Cooler	Graham Mfg. Co.
Circulating Water Pumps	Worthington Pump & Machinery Corp.
Heat Exchanger	Ross Heater & Mfg. Co., Inc.
Auxiliary Oil Pump and Fuel Pumps	Roper
Turbocharger	Elliott Co.
Oil & Gas Meters	Rockwell Mfg. Co.



This 1440-hp Superior dual-fuel, diesel engine generator unit has operated almost entirely on 1000-Btu natural gas since it was installed as a supplemental power source in the Ames, Iowa, Municipal Power Plant

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

☆

DON'T BE SATISFIED

In a letter from a reader, which appears in the Letters To The Editors section of this issue, he directs attention to an important element in the maintenance of power equipment that, too often, is given no thought whatever. This is the possibility of improving parts of the equipment which require frequent adjustment or replacement so that they will no longer need such frequent adjustment or replacement. Mechanical parts subject to rapid wear, electrical parts subject to burning erosion or mechanical flexing, gaskets and packing which deteriorate under the action of extreme temperature or pressure, elements which continually loosen under the action of vibration, and many other things of a similar nature can often be improved permanently by some serious study and a little effort. In other words, the best kind of maintenance is that which eliminates the need for maintenance.

This same general idea can be applied to branches of engineering other than that of maintenance, in the field of design, for example. One of the greatest deterrents to continued progress is the tendency to be satisfied with things as they are. Just because a machine, or a method, or a system as a whole has reached a high state of perfection, is no reason for assuming that further improvements cannot be made by means of an entirely new approach. If electrical engineers and scientists had rested when they developed the incandescent lamp to a high degree of perfection we never would have had the fluorescent lamp.

It is well therefore to take a critical view of every piece of equipment that we deal with, of every method we employ; study them, compare them with equipments and processes in other fields, examine them in the light of new developments and new materials, new requirements; you will never know until you do this whether further improvement cannot be made. In the October issue we expect to present an article which applies this sort of thinking to the field of electrical generator design. In the meantime, you can be thinking about it.

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A Section of Power Engineering Devoted to
PLANT OPERATION AND MAINTENANCE
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Water and Sediment in Fuel Oils

This is the sixth installment of Mr. Schmidt's series on the characteristics of fuel oils. Here he describes methods of testing for sediment, causes of BSW and sludge and troubles due to BSW and sludge

By PAUL F. SCHMIDT
Allied Oil Company, Inc., Cleveland, Ohio

ONE OF THE GREATEST sources of trouble in all grades of fuel oils is the water and sediment sometimes found with the oil. This water and sediment, or BSW as it is called (bottom sediment and water), will vary greatly in amount and composition. The approximate amounts of BSW found in the various grades of oils are as follows:

Grade	Per cent
No. 2 oil	nil to 0.20
No. 4 oil	0.10 to 0.50
No. 5 and 6 oils	0.20 to 2.00

When the percentage is over 2.00, the oil is usually contaminated by outside sources, as will be explained later in this article.

Methods of Testing

Testing for water and sediment is accomplished by three different methods. The first is the BSW test by Centrifuge, which is the most common method. This test is conducted by diluting the oil with benzol in a glass tube, and then whirling it in a centrifuge. The centrifugal force will throw any water and sediment to the bottom of the calibrated tube, thus indicating the total percentage of water and sediment present in the oil.

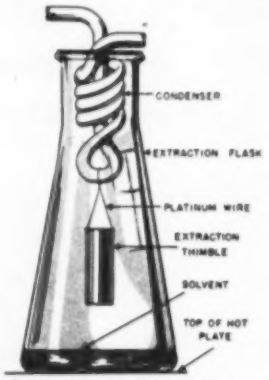
According to the standard method of running this test, the solvent should be benzol. Some laboratories do not use this type of solvent, but use either gasoline or a naphtha. When using those materials in place of the benzol, very inaccurate results may be obtained. Due to various compositions of fuel oils, their solubility in different solvents will vary, which means that they may be completely soluble in benzol but not in other solvents.

Water By Distillation Test

The second method is the Water by Distillation test. In this method, the oil is mixed with gasoline to dilute the oil, and then distilled. The gasoline and water vapors are condensed, and the liquids drop into a calibrated tube. The water, being heavier than the gasoline, falls to the bottom and is then measured. This test gives only the amount of water present in an oil.

Sediment By Extraction Test

The third method is Sediment by Extraction. This test is run by measuring a certain amount of oil into a porous alundum crucible and suspending it inside a flask, in which there is a quantity of benzol on the bottom. The top of the flask is covered by a small coiled condenser,



Sediment by extraction apparatus

cooled by water running through it. As the benzol is heated and vaporized, the vapors are condensed on this condenser. The liquid drops into the porous crucible, dissolving the oil which in turn flows through the pores of the crucible. These pores are large enough to permit the liquid to drain, but small enough to retain the sediment. When all the oil has been dissolved from the crucible, with only the sediment remaining, the crucible is dried and weighed. Thus the percentage of sediment is obtained.

According to the standard fuel oil specifications, the BSW by Centrifuge is used for No. 2, 4 and 5 oils, while the Sediment by Extraction test is used for No. 6 oils. The reason for this is due to the high viscosities encountered in No. 6 oils, which makes separation of sediment and water by centrifugal force impracticable.

Composition of BSW And Sludge

Technically, there is a difference between BSW and sludge. The BSW is the water and sediment, such as dirt, grit, tank scale, and similar material. Sludge is the oxidation product, or chemical compounds, resulting from the oxidation of the hydrocarbons in the oil, forming insoluble material. BSW and sludge are terms which frequently refer to the contamination on the bottom of storage tanks, but they are also used to describe the foreign materials found floating or suspended in the fuel oils themselves. The term "sludge" is used quite loosely, and is generally understood to mean a combination of BSW and sludge.

The composition of BSW and sludge found in oils and on bottoms of storage tanks may be composed of any, or all of the following materials.

1. Gum, resins, asphaltenes, produced by chemical reactions, or by incomplete solubility of various mixtures of different oils. These materials are chemical compounds of various types, usually heavy and viscous, and combustible, but having a tendency to block screens and strainers, as well as carbonizing in preheaters.

2. Free carbon, found sometimes in cracked oils which was thrown out during the cracking process. This material is also combustible, but can block small openings, such as in screens and at burner tips.

3. Water, free and mixed with the sludge. The water may contain soluble chemical compounds, which originally came with the crude oil.

4. Mud, sand, and stones, from badly covered openings in storage tanks.

5. Wood splinters and twigs, same reason as No. 4.

6. Tank scale or rust, the result of excessive water.

7. Gasket material and pump hose shreds, usually coming from worn and battered manhole gaskets and pump hoses.

8. Rags and rag shreds, from cleaning rags used to wipe the gauging stick or that used as stoppers or covers for gauging holes, which eventually slip down the pipe and into the tank.

9. Congealed, thickened, heavy residual fuel oils. With some blended oils, particularly in cold weather, there is sometimes encountered chunks or globules of a thick, greasy-looking substance floating in the oil. This is generally congealed parts of the oil or wax, formed as a result of low temperatures.

All of these contaminants may be present at one time, and then again maybe only a few. Some may be delivered with the oil, or they may become accumulated within the tank. You may think that such a mixture is not possible or at least not frequently, but unfortunately at least 5 are almost always present on the bottom of the fuel oil tanks. This is especially true with the heavy oils, while in the light oil storage tanks the conditions may be the same, but the volume of sludge being much smaller.

Causes of BSW And Sludge

Leaking tanks are not common, but the construction of the manholes and covers, as well as connections, may sometimes be poorly made.

No matter how clean an oil is, there is a slow chemical reaction. Some chemical compounds present in an oil will absorb oxygen from the air or water to form new compounds. Unfortunately some of these new compounds are insoluble in the main portion of the oil, with the result that they will either remain suspended in the oil, or will drop to the bottom of the tank as sludge.

Some operators heat their tanks to excessive temperatures. This heat hastens the chemical reaction but causes a great amount of water to condense inside the tank. This water will cause rust, which helps to oxidize the oil.

Mixing different grades and types of oils will sometimes create a large amount of BSW. This is due mostly to the solubility of the different oils. Some will be completely soluble in each other, while some will not. Also some blended oils are not stable, and will throw out some deposits. This may also be the case at high temperatures where there may be complete solubility, but at lower temperatures precipitation of the material may occur, due to its insolubility at this lower temperature. Sometimes in cold weather the wax present in certain types of oils will drop out.

Troubles Due to BSW and Sludge

Some of the difficulties encountered with water, sediment and sludge are listed.

1. Complete stoppage of operation and combustion.
2. Erratic and unsteady combustion.
3. Sparkling and spitting of the flame.
4. Flash-back of the flame.
5. Blocking and plugging of burner tips and screens.
6. Loss of heat.
7. Erosion of burner tips and mechanical parts.

Items 1, 2, 3, 4, and 5 all go hand in hand, as blocked screens will not permit oil to go through to the burner, or not enough for satisfactory combustion. Water causes sparkling and spitting of the flame. The flame may go out completely if too much water is present, and may be slow in igniting as the oil comes back through the burner, causing flash-back. All of this results in loss of heat from the improper combustion, and also the percentage of good clean oil to furnish the heat is reduced. The erosion of burner tips, pump parts, and sensitive control valves results from certain types of sediments, as sand and grit.

Periodic inspection of the storage tanks should be made, or at the first sign of trouble the tank should be sampled and the amount of accumulated sludge determined. In case of trouble a sample of the oil should be taken from the line leading to the burner, as this will give a good indication of the material that is being burned at that particular time.

FANS AND FICTION

By V. N. FRIEDMAN

NOW THAT SUMMER is here[1] fan advertisements and descriptive literature make numerous claims about particular fans. Some of these claims are rather extravagant if not fantastic.

The ordinary fan used for office or home ventilation is usually of the disc or propeller type and is built without housing, for free air delivery. The capacity of this fan in cubic feet of air per minute, neglecting temperature, density, moisture and pressure, is dependent on fan blade diameter, speed, the angle of the blades with the plane of rotation and the construction. By construction, is meant the presence or absence of cone inlets, ducts, housing, etc.

In reading descriptions of different makes of fans it is confusing to try to analyze and properly evaluate ratings. For example, some fans are rated in air delivery with readings taken a distance of one foot in front of the fan; others with readings taken two feet in front of the fan; still others with readings taken four feet in front of the fan. Some are rated according to established standard fan testing codes. A number do not state how capacities are determined. Needless to say, the results vary with the method of taking readings.

If volumes are determined by an anemometer it is important that readings be taken in a number of locations in front of the fan and these readings averaged. This is so because the highest readings will be obtained in front of the blade tips where the peripheral speed is highest and the lowest readings will be near the hub.

Another form of rating is rather misleading and evasive. It lists air delivery as a certain quantity in TWO minutes but the two is not capitalized as is done here. Thus, a person reading a fan description hurriedly may miss the TWO and get a wrong conception of the fan capacity.

Another misleading rating of home fans is that based on the number of rooms the fan in question will ventilate. This sort of rating ignores the facts that all buildings are not constructed the same and are in different locations. Thus a room on the top floor of an uninsulated building would "soak up" heat during the day to a greater extent than the top floor of a house with an attic, dead-air space or insulation. Again, one of two similarly constructed buildings might have a vastly smaller amount of heat stored in it during the day if it is in the shade of another building or a large tree. Also, the arrangement of the rooms is a factor.

With an outside day temperature of, say 95 deg, an uninsulated space under the roof may rise to some 130 or 135 deg. During the night the outside temperature will drop to, say 70 deg. The fan then circulates the lower temperature air at night and carries away the stored up heat of the day. The number of air changes per hour, of course, will vary with the particular installation and location but a volume change of one per minute should be ample in most locations.

There is no set figure on volume capacity for ventilation for all installations as there are no set figures for heating requirements in cold weather or air conditioning in warm weather that will apply to all installations.

The best way to select the proper fan for home or office ventilation is to total the cubic feet of the rooms to be independently ventilated and then select a fan with a capacity equal to that number of cubic feet per minute or a fraction of it depending upon the number of changes required in the particular installation and locality. If a change of air is to be made once a minute in the ventilated space then the fan capacity in cfm should equal the total cubic feet of space to be ventilated. If a change of air is required only every two minutes then the fan capacity in cfm would be half of the total ventilated cubic feet.

It should be remembered that the higher speed fans are noisy and the accompanying high air velocity may be uncomfortable. Thus it usually is advisable to install a slow speed belted fan of larger diameter in order to get capacity as well as low speed. The motor can be relatively high speed, say 1725 rpm. A multi-speed motor may be desirable if the need for ventilation varies or it is desirable to have less ventilation in the early morning hours.

A free air delivery fan outlet should not be obstructed by an ordinary mesh screen as the fan output and efficiency will be lowered by such an obstruction. The ordinary disc or propeller fan air output drops rapidly with an increase of back pressure or resistance.

[1] Summer was here when Mr. Friedman submitted this article but it is probably not too late to call attention to this matter. Editor.

THE PRACTICAL ENGINEER AND ELECTRICIAN

Basic Power Plant FIGURING

A Review for Old-Timers

A Must for Young-Timers

By WILLIAM H. ENGELMAN

Mechanical Engineer

Department of Water & Light
City of Cleveland, Ohio

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Comparison of Different Steam Turbine Expansion Lines and Rankine Cycle Efficiencies

HERE ARE some steam turbine adiabatic expansion lines (isentropic or expansion at constant entropy) to give you practice in visualizing different conditions in a theoretically perfect turbine at different initial and final conditions of the steam. It will give you practice in spotting points on the Mollier diagram and visualizing how the pressure, temperature, moisture and volumes vary as you expand steam in turbines from higher to lower conditions.

In the August issue the author showed the meaning of actual thermal efficiency and Rankine cycle efficiency and explained why they are used. The lines on the Mollier diagram that are drawn between the initial and final conditions of the steam are called condition lines. They represent the gradual change in the characteristics of the steam as it passes through the turbine.

The lines shown in Fig. 1 are adiabatic expansion lines and it must be remembered that in actual turbines the expansion is never exactly adiabatic. There are losses caused by friction and eddy-currents so that the actual expansion line slants to the right as shown in Fig. 3, August issue. Not all the energy available to be converted into work is converted—only about 70 to 85 per cent of it in most turbines.

That is, the adiabatic or constant entropy Btu drop, or Btu converted to work, $H_1 - H_2$, is what you would convert into energy in a theoretically perfect turbine with no losses. But you actually convert only 70 to 85 per cent of that, the unconverted energy remaining as heat in the steam.

Moreover, that adiabatic Btu drop in itself only the amount of energy that you could theoretically get out of the steam in a perfect expansion with no losses. The total available energy in each pound of steam is $H_1 - h_{f_2}$.

The various diagrams of Fig. 2 show these relations for each of the condition lines plotted in Fig. 1.

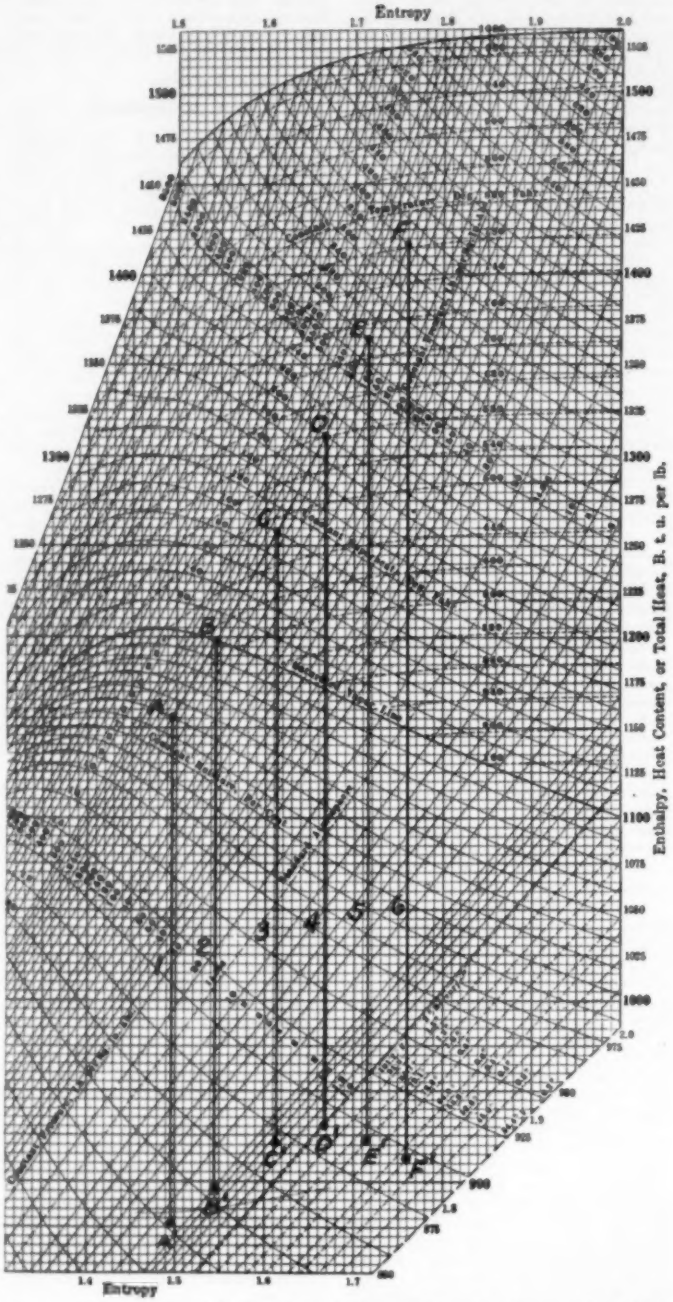


Fig. 1. Major portion of Mollier chart, showing condition lines for several adiabatic expansions of steam in turbines

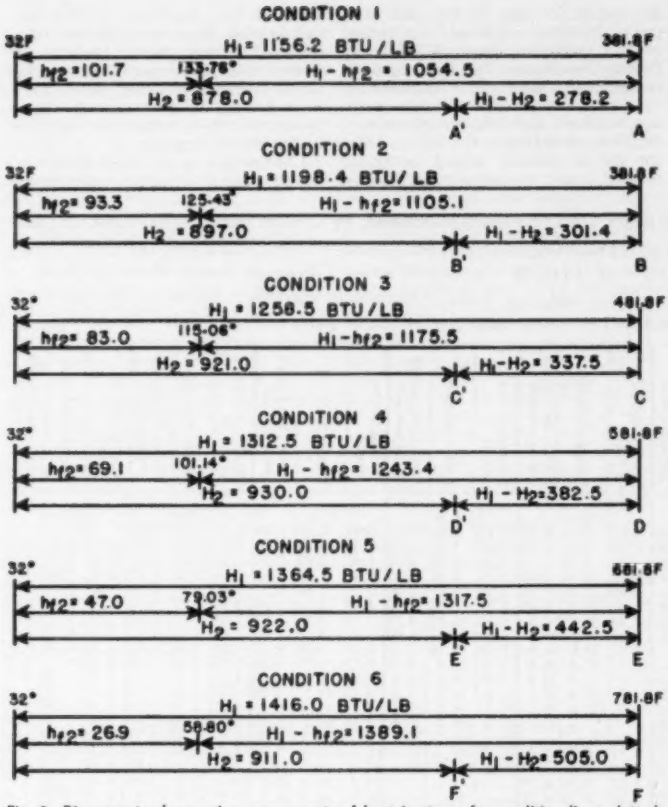


Fig. 2. Diagrams to show various components of heat in steam for condition lines plotted in Fig. 1

Comparison of Steam Turbines Operating Under 6 Different Conditions. Expansion at Constant Entropy. Vacuum Referred to 30 in. Barometer

Items a, b, c and d given	Condition No.					
	1	2	3	4	5	6
a. Steam pressure, psia	200	200	200	200	200	200
b. Quality of steam, %	95	100	—	—	—	—
c. Superheat, deg F	—	—	100	200	300	400
d. Exhaust Vacuum, in. Hg	25	26	27	28	29	29.5
e. Total temperature deg F	381.8	381.8	481.8	581.8	681.8	781.8
f. Initial & final entropy	1.496	1.545	1.613	1.668	1.715	1.759
g. Btu per lb, initial steam H_1	1156.2	1198.4	1258.5	1312.5	1364.5	1416.0
h. Btu per lb, exhaust steam H_2	878.0	897.0	921.0	930.0	922.0	911.0
i. Btu drop, $H_1 - H_2$	278.2	301.4	337.5	382.5	442.5	505.0
j. Moisture in exhaust, %	23.7	21.5	18.5	16.9	16.6	16.6
k. Btu per lb of the liquid, h_{f2}	101.7	93.3	83.0	69.1	47.0	26.9
l. Steam rate, lb per hphr, W	9.15	8.44	7.54	6.65	5.75	5.04
m. Decrease, steam rate against Item 1 %	0	7.75	17.50	27.30	37.10	44.90
n. Rankine Cycle efficiency %	26.38	27.27	28.71	30.76	33.58	36.35
o. Increase in efficiency over Condition No. 1 %	0	3.37	8.83	16.60	27.30	37.80
p. Increase in efficiency over previous condition %	0	3.37	5.32	7.10	9.17	8.25
q. Initial volume cu ft per lb	2.18	2.28	2.65	3.00	3.32	3.64
r. Final volume, cu ft per lb	109	139	188	282	544	1045
s. Volume Ratio, q to r	1 : 50	1 : 61	1 : 71	1 : 94	1 : 164	1 : 287

(Continued on page 85)

Basic Power Plant FIGURING

Discussion by SABIN CROCKER
Mechanical Engineer
Ebasco Services, Inc.

Of

Article on

How To Calculate Steam and Water Piping and Power Requirements for Steam-Turbine-Driven Centrifugal Boiler Feed Pumps and Other Centrifugal Pumps

***Power Engineering*, June, 1950, pages 84-85**

The author, one of the authorities on modern piping practice, points out basis for Williams and Hazen tables, compares them for boiler feed pump and piping conditions with the Saph and Schoder tables, which are shown here. Use of Williams and Hazen C—100 values with good feedwater and clean boiler feed piping may give friction loss 50% higher than Saph and Schoder values, resulting in too large piping or too high a pump discharge pressure

BESIDES affording an excellent review in methods of calculation, the series of articles on Basic Power Plant Figuring by Mr. Engelman serves to call attention to sources of data available for use in such calculations. In this connection the writer is pleased to note that Mr. Engelman saw fit to refer to *Piping Handbook* by Sabin Crocker as a reference for obtaining Williams and Hazen friction losses. The use of these values for boiler feed piping raises a question, however, which the writer would like to take this opportunity to discuss.

Originally the Williams and Hazen formulas and their tables were intended for use by water-works engineers in designing underground piping for municipal water supply systems and the like. Such pipe is usually kept in service for 50 to 100 years or more carrying water that causes tuberculation or encrustation to a greater or lesser degree depending on local conditions. Such piping also may be subject to some clogging with sediment where water velocities are low. For instance, hard waters and lake waters sometimes attack pipe only half as fast as soft and clear but unfiltered river waters. In one case, C=100 might be a safe figure to use, whereas C=65 might be called for under worse conditions if adequate carrying capacity over a long period of years is required.

On the other hand, for boiler feed or condensate piping in a power sta-

tion operating on distilled and/or chemically treated water, it is customary to use a Williams and Hazen C value of the order of 125 to 130. This agrees with the Saph and Schoder values for pipe having their interior in "fair condition" as given in the table on Pages 274-275 of *Piping Handbook*, 4th Edition, and reproduced here for convenient reference. It is also customary to use the Saph and Schoder values (or Williams and Hazen C = 125 to 130) for power station piping carrying treated water in closed cooling systems. In fact, the Saph and Schoder values also have been found adequate for raw water systems in power stations operating in the Great Lakes region and other locations having water not particularly conducive to causing tuberculation in the piping system.

Comparison of corresponding friction values in the above mentioned

Saph and Schoder table for water, from pages 274-275, *Piping Handbook*, by Crocker (McGraw-Hill Book Co., Inc.)

TABLE XLII.—CARRYING CAPACITY AND FRICTION LOSS FOR STANDARD-WEIGHT WROUGHT-IRON AND STEEL WATER PIPES, ALSO APPROXIMATE FOR TYPE K COPPER WATER TUBES OF SAME NOMINAL SIZE

(Independent variables: gallons per minute and pipe size. Dependent variables: velocity, friction head, and pressure drop. Friction head and pressure drop per 100 ft of pipe, interior "fair" condition)

Gallons per minute	¾ in.			1 in.			1¼ in.			1½ in.			2 in.			2½ in			3 in.		
	Velocity, feet per second	Friction head, feet	Friction loss, pounds per square inch	Velocity, feet per second	Friction head, feet	Friction loss, pounds per square inch	Velocity, feet per second	Friction head, feet	Friction loss, pounds per square inch	Velocity, feet per second	Friction head, feet	Friction loss, pounds per square inch	Velocity, feet per second	Friction head, feet	Friction loss, pounds per square inch	Velocity, feet per second	Friction head, feet	Friction loss, pounds per square inch	Velocity, feet per second	Friction head, feet	Friction loss, pounds per square inch
5	3.00	8.30	3.60	1.86	2.54	1.10	1.07	0.65	0.28	0.79	0.30	0.13	0.48	0.09	0.04	0.33	0.04	0.02			
10	6.00	23.7	10.3	3.71	9.00	3.90	2.14	2.31	1.00	1.57	1.06	0.46	0.96	0.30	0.13	0.67	0.12	0.05	0.43	0.04	0.02
15	9.00	62.3	27.0	5.56	18.9	8.20	3.20	4.90	2.12	2.36	2.24	0.97	1.43	0.65	0.28	1.00	0.27	0.12	0.65	0.09	0.04
20	12.0	113.0	49.0	7.42	33.2	14.4	4.27	8.44	3.65	3.14	3.81	1.65	1.91	1.08	0.47	1.34	0.46	0.20	0.87	0.16	0.07
25	15.0	166.0	72.0	9.27	49.8	21.6	5.35	12.7	5.50	3.93	5.77	2.50	2.39	1.66	0.72	1.67	0.69	0.30	1.08	0.23	0.10
30				11.1	71.5	31.0	6.42	18.0	7.80	4.72	8.08	3.50	2.87	2.31	1.00	2.01	0.97	0.42	1.30	0.32	0.14
35		4 in.		13.0	95.0	41.2	7.48	24.9	10.8	5.50	10.85	4.70	3.34	3.05	1.32	2.34	1.29	0.56	1.51	0.44	0.19
40	1.01	0.14	0.06	14.9	121.0	52.6	8.56	31.7	13.7	6.30	13.85	6.00	3.82	3.92	1.70	2.68	1.66	0.72	1.73	0.55	0.24
45	1.13	0.18	0.08				9.62	39.0	16.9	7.07	17.10	7.40	4.29	4.88	2.12	3.01	2.08	0.90	1.95	0.69	0.30
50	1.26	0.21	0.09		5 in.		10.7	47.4	20.5	7.86	21.0	9.10	4.77	5.95	2.58	3.35	2.49	1.08	2.16	0.85	0.37
60	1.51	0.30	0.13	0.96	0.09	0.04	12.8	66.6	28.8	9.44	30.0	13.0	5.73	8.30	3.60	4.02	3.51	1.52	2.59	1.20	0.52
70	1.76	0.42	0.18	1.12	0.14	0.06	14.9	88.4	38.2	11.0	39.7	17.2	6.68	11.1	4.80	4.68	4.66	2.02	3.02	1.57	0.68
75	1.89	0.46	0.20	1.20	0.16	0.07	16.0	100.0	43.2	11.8	44.8	19.4	7.16	12.6	5.45	5.02	5.31	2.30	3.24	1.80	0.78
80	2.01	0.53	0.23	1.28	0.18	0.08				12.6	51.8	22.4	7.64	14.1	6.10	5.37	6.00	2.60	3.47	2.03	0.88
90	2.27	0.65	0.28	1.44	0.21	0.09		6 in.		14.1	63.2	27.4	8.59	17.5	7.60	6.03	7.38	3.20	3.89	2.54	1.10
100	2.52	0.78	0.34	1.60	0.26	0.11	1.11	0.09	0.04	15.7	76.2	33.1	9.55	21.5	9.30	6.71	9.00	3.90	4.34	3.05	1.32
125	3.14	1.20	0.52	2.00	0.39	0.17	1.39	0.16	0.07	19.6	116.2	50.4	11.9	33.2	14.4	8.37	13.8	6.00	5.42	4.62	2.00
150	3.77	1.68	0.73	2.40	0.55	0.24	1.67	0.21	0.09				14.3	46.4	20.1	10.1	19.4	8.40	6.50	6.47	2.80
175	4.42	2.26	0.98	2.80	0.74	0.32	1.94	0.30	0.13		8 in.		16.7	61.5	26.7	11.7	25.6	11.1	7.58	8.76	3.80
200	5.04	2.88	1.25	3.20	0.92	0.40	2.22	0.37	0.16	1.28	0.09	0.04	19.1	78.3	33.9	13.4	33.2	14.4	8.67	11.2	4.85
250	6.30	4.38	1.90	4.00	1.41	0.61	2.78	0.58	0.25	1.60	0.14	0.06	23.9	119.5	51.8	16.7	49.8	21.6	10.8	17.1	7.40
300	7.55	6.07	2.63	4.80	2.01	0.87	3.35	0.81	0.35	1.92	0.18	0.08	28.6	166.0	72.0	20.1	69.7	30.2	13.0	23.5	10.2
350	8.80	8.07	3.50	5.60	2.65	1.15	3.90	1.06	0.46	2.24	0.27	0.12				23.5	93.0	40.3	15.2	31.7	13.7
400	10.1	10.4	4.50	6.40	3.39	1.47	4.45	1.36	0.59	2.56	0.35	0.15		10 in.					17.3	40.2	17.4
450	11.3	12.9	5.60	7.20	4.27	1.85	5.00	1.71	0.74	2.88	0.42	0.18	1.83	0.14	0.06		12 in.		19.5	49.8	21.6
500	12.6	15.7	6.80	8.00	5.07	2.20	5.55	2.05	0.89	3.20	0.51	0.22	2.03	0.16	0.07	1.42	0.07	0.03	21.7	61.5	26.6
750	18.9	34.0	14.7	12.0	10.9	4.75	8.34	4.34	1.88	4.80	1.09	0.47	3.05	0.35	0.15	2.12	0.14	0.06			
1,000				16.0	18.7	8.10	11.1	7.38	3.20	6.40	1.87	0.81	4.07	0.60	0.26	2.83	0.25	0.11		14 in.	¾ in.
		16 in.	¾ in.																	O.D.	thick
1,250		O.D.	thick		18 in.	¾ in.	13.9	11.1	4.80	8.00	2.81	1.22	5.07	0.90	0.39	3.53	0.37	0.16	2.90	0.23	0.10
1,500	2.63	0.16	0.07		O.D.	thick	16.7	15.7	6.80	9.60	3.92	1.70	6.10	1.25	0.54	4.25	0.51	0.22	3.50	0.32	0.14
2,000	3.51	0.28	0.12	2.75	0.14	0.06				12.8	6.69	2.90	8.13	2.17	0.94	5.65	0.90	0.39	4.65	0.55	0.24
2,500	4.39	0.42	0.18	3.43	0.23	0.10		20 in.	¾ in.	16.0	10.1	4.40	10.2	3.23	1.40	7.05	1.34	0.58	5.82	0.89	0.36
3,000	5.27	0.58	0.25	4.12	0.30	0.13		O.D.	thick	19.2	14.1	6.10	12.2	4.62	2.00	8.50	1.89	0.82	7.00	1.15	0.50
3,500	6.15	0.76	0.33	4.81	0.42	0.18	3.86	0.23	0.10				14.2	6.24	2.70	9.93	2.52	1.09	8.15	1.55	0.67
4,000	7.03	0.97	0.42	5.49	0.53	0.23	4.41	0.30	0.13		24 in.	¾ in.	16.3	7.99	3.46	11.3	3.23	1.40	9.31	1.99	0.86
4,500	7.91	1.22	0.53	6.18	0.65	0.28	4.96	0.37	0.16		O.D.	thick	18.3	9.93	4.30	12.8	4.04	1.75	10.5	2.47	1.07
5,000	8.78	1.48	0.64	6.86	0.81	0.35	5.51	0.46	0.20	3.78	0.18	0.08				14.2	4.92	2.13	11.6	3.00	1.30
5,500	9.66	1.78	0.77	7.55	0.95	0.41	6.06	0.55	0.24	4.16	0.21	0.09		30 in.	½ in.	15.6	5.87	2.54	12.8	3.58	1.55
6,000	10.5	2.08	0.90	8.24	1.13	0.49	6.62	0.65	0.28	4.53	0.25	0.11		O.D.	thick	17.0	6.88	2.98	14.0	4.20	1.82
6,500	11.4	2.40	1.04	8.92	1.29	0.56	7.16	0.74	0.32	4.91	0.30	0.13	3.16	0.09	0.04				15.1	4.85	2.10
7,000	12.3	2.77	1.20	9.61	1.50	0.65	7.72	0.85	0.37	5.29	0.35	0.15	3.40	0.12	0.05		36 in.	¾ in.	16.3	5.59	2.42
7,500	13.2	3.14	1.36	10.3	1.71	0.74	8.27	0.99	0.43	5.67	0.39	0.17	3.64	0.12	0.05		O.D.	thick	17.5	6.35	2.75
8,000	14.1	3.56	1.54	11.0	1.92	0.83	8.82	1.11	0.48	6.05	0.44	0.19	3.89	0.14	0.06	2.75	0.07	0.03	18.6	7.16	3.10
9,000	15.8	4.41	1.91	12.4	2.38	1.03	9.92	1.39	0.60	6.80	0.53	0.23	4.37	0.18	0.08	3.09	0.07	0.03			
10,000				13.7	2.91	1.26	11.0	1.69	0.73	7.56	0.65	0.28	4.86	0.21	0.09	3.43	0.09	0.04		42 in.	¾ in.
11,000				15.1	3.47	1.50	12.1	2.01	0.87	8.31	0.79	0.34	5.34	0.25	0.11	3.78	0.12	0.05		O.D.	thick
12,000				16.5	4.07	1.76	13.2	2.36	1.02	9.07	0.92	0.40	5.83	0.30	0.13	4.12	0.14	0.06	2.99	0.05	0.02
13,000							14.3	2.73	1.18	9.83	1.06	0.46	6.32	0.35	0.15	4.46	0.14	0.06	3.24	0.07	0.03
14,000							15.4	3.14	1.36	10.6	1.22	0.53	6.80	0.39	0.17	4.80	0.16	0.07	3.49	0.07	0.03
15,000							16.5	3.56	1.54	11.3	1.39	0.60	7.29	0.46	0.20	5.15	0.18	0.08	3.74	0.09	0.04
20,000										15.1	2.38	1.03	9.71	0.79	0.34	6.86	0.32	0.14	4.98	0.14	0.06
25,000													12.1	1.20	0.52	8.58	0.51	0.22	6.23	0.23	0.10
30,000													14.6	1.66	0.72	10.3	0.69	0.30	7.47	0.32	0.14
35,000													17.0	2.22	0.96	12.0	0.92	0.40	8.72	0.42	0.18
40,000																13.7	1.20	0.52	9.96	0.53	0.23

Friction head and pressure drop from curves based on Saph and Schoder formula: $p_h = \frac{(G.P.M.)^{1.86}}{14.35 \times d^5}$ in which p_h = pressure drop, psi per 100-ft pipe and d = inside diameter of pipe, inches. Applies to pipe with interior in "fair" condition. Based on 62.428 lb per cu ft. To convert gallons per minute to cubic feet per second, divide by 448.8; to convert gallons per minute to pounds per hour, multiply by 500.7; to convert gallons per minute to millions of gallons per day, divide by 694.4. See also Table XLVIII for conversions.

Saph and Schoder table with the Williams and Hazen table for C—100 shows the latter to give friction losses of the order of 50 per cent in excess of the former. To overdesign power station piping to compensate for an assumption of friction losses 50 per cent in excess of what is reasonable to expect constitutes a serious economic loss. It results in one of two things: either too much money is spent on oversize piping; or the pumps are bought for too high a head and operate throughout their life at a higher discharge pressure than actually needed.

The writer wishes to drive these points home because he has been concerned to note recently that some pump manufacturers have published flow tables for Williams and Hazen C=100 that in his opinion are being misapplied to the design of power station piping. While the pump manufacturer may like to feel that he has provided for himself a hidden margin to insure the adequate performance of his pump, the writer contends that this should not be done by using a fictitious friction factor containing a margin not understood by the engineers responsible for station design.

Where piping serves to convey water that is inclined to produce tuberculation or encrustation or excessive slime deposits inside the pipe, it is reasonable to use a Williams and Hazen C value of 100 or less, depending on how fast deposits are formed and how long the pipe is expected to continue in service. As mentioned previously, however, most power station water piping is not subject to such attack. At one time or another the writer has seen the inside of a great deal of such piping after prolonged periods of service. Most of this piping had a light inside coating of red or black iron oxide as distinguished from tuberculations or encrustations or slime. The general nature of the deposit was fine grained, and it was too uniform and thin to constitute any appreciable obstruction of the pipe bore. The interior condition of such piping is practically equal to "new clean pipe" corresponding to a Williams and Hazen C value of the order of 125 to 130.

For the reasons stated above the writer wishes to offer a word of caution against using a Williams and Hazen C value as low as 100 for the design of power station water piping, particularly boiler feed, condensate, or treated water in closed cooling systems.

Editor's Note:—This discussion by Mr. Crocker, as well as the method of calculation of boiler feed piping and feed pump discharge pressure given by Mr. Engelman if the June issue should be of particular value in connection with the article in this issue on How to Select Centrifugal Boiler Feed Pumps, by Igor J. Karassik. In the latter article, method of calculating feed pump discharge pressure is outlined, see Fig. 13, and in particular cases, where it is necessary to calculate pipe friction, the method must be worked out as indicated by both Messrs. Karassik and Engelman, observing at all times the cautions given by Mr. Crocker, in order to avoid over-design and resulting economic loss.

BASIC POWER PLANT FIGURING

(Continued from page 83)

How Values Were Obtained for Items e to s Inclusive

e. Total Temperature is temperature of saturated steam plus degrees superheat.

f. Entropy is that of the initial and the exhaust steam and is constant during adiabatic expansion. (constant entropy.)

g. Enthalpy of the initial steam in Btu per lb.

h. Enthalpy of the exhaust steam in Btu per lb.

i. Enthalpy given up during adiabatic expansion, the heat drop.

j. Moisture in exhaust steam due to adiabatic expansion, in per cent.

k. Enthalpy of the liquid, given in Table 2 of the steam table, thus:
30 — 25 is 5 in. Hg absolute, giving a temperature of 133.76 F and the enthalpy is 101.66 Btu per lb.
This may also be located on the Ellenwood-Mackey chart, where the temperatures are given at saturation line, then deducting 32 deg.

l. Steam rate $W = \frac{2544.1}{H_1 - H_2} = \frac{2544.1}{\text{item i}} = \frac{2544.1}{278.2} = 9.15$ lb per hp-hr theoretical
One horsepower-hour equals 1,980,000 ÷ 778.26 = 2544.1 Btu.
One kilowatt-hour equals 2,656,000 ÷ 778.26 = 3412.75 Btu. **Use 3413 Btu.**

m. The decrease of the steam rate in per cent against Item l is
(9.15 — 8.44) ÷ 9.15 = 0.0775 or 7.75 per cent.

n. The Rankine Cycle Efficiency is $\frac{H_1 - H_2}{H_1 - h_{f2}} = \frac{\text{item i}}{H_1 - h_{f2}}$ (a decimal)

o. Increase in efficiency = (27.27 — 26.38) ÷ 26.38 = 0.0337 or 3.37%

p. Increase in efficiency = (28.71 — 27.27) ÷ 27.27 = 0.0532 or 5.32%

q. Volume of initial steam is 2.18 cu ft/lb. (See Ellenwood-Mackey Charts.)

r. Volume of exhaust steam is 109 cu ft/lb. (See Ellenwood-Mackey Charts.)

s. Volumetric Ratio of q to r is 2.18 : 109 or 1 : 50.

How to Find the Volume of Steam Containing Moisture

For low and medium pressures the volume of saturated steam having a certain quality can be computed as follows:

Volume is volume of dry saturated steam times the quality (a decimal).

Example: Find volume of steam at 100 psia and 90 per cent quality.
v_g at 100 psia is 4.432 cu ft per lb and 4.432 × 0.9 = 3.989 cu ft.

The error is extremely small, due to the small volume of the liquid against that of the large volume of the steam, both given in cu ft per lb.

In the above tables and diagrams, Values for Items e to r inclusive were obtained from:
Thermodynamic Charts by Ellenwood & Mackey, John Wiley & Sons, 440 Fourth Ave., N. Y.
Thermodynamic Properties of Steam (Steam Tables) by Keenan & Keyes, John Wiley & Sons.
Mollier Chart of Steam Properties, John Wiley & Sons.

MAINTAINING ELECTRICAL APPARATUS FOR HAZARDOUS LOCATIONS

THE SAFE performance of explosion-proof electrical apparatus depends upon the care exercised in assembling its enclosures. The time required for proper assembly of covers or other parts is a small investment reaping large rewards in the form of safety which can be assured in no other way.

As pointed out recently by A. T. Williams in Westinghouse Maintenance News, it must be realized that Class 1 apparatus will be subject to explosions within the enclosure when a combustible mixture has accumulated and is ignited by an arc or spark. Under this condition, the flame paths must be long enough and of such close clearance that fire will be arrested before it reaches the surrounding hazardous atmosphere.

The joints of Class 2 apparatus must prevent dust from entering the enclosure where it might interfere with the operation of the device, causing overheating, dielectric flashover, or internal explosion. Overheating may cause the dust on the outside of the enclosure to be ignited, resulting in fire or explosion.

While it is the responsibility of the manufacturer to design and build a piece of electrical equipment which has been found by test to meet the requirements of Underwriters' Laboratories, it is necessary for the user to properly install and maintain this apparatus if it is to function safely and properly. The following suggestions may be of assistance to those who have electrical equipment, in hazardous locations, under their supervision.

1. All ground joint surfaces must be protected against injury. Be careful in removing and replacing the covers not to damage the machined surfaces. Do not stand the covers on edge on a hard surface or otherwise impair the joint surfaces.

2. Remove all dirt, sealing com-

pound or paint which may have accidentally accumulated on the joint surfaces. Grease is applied to prevent corrosion during shipping and small particles of sand or other foreign material may adhere to the greased surface.

3. Before the cover is applied, a thin film of new grease or petrolatum (vaseline) should be spread over both surfaces. The manufacturer of the apparatus will be glad to recommend greases which have been found, by test at the Underwriters' Laboratories, to be suitable for the purpose. Attention to this detail will help to prevent corrosion and to keep the joints in good condition.

4. Pull the cover down evenly and tightly but not so tightly as to strain the bolts.

5. Devices with threaded covers should be tight enough to prevent their loosening in service, and the threaded joints should have at least five fully engaged threads.

Pointers on Electrical Maintenance

By **HOWARD T. BAILEY**
Chief Electrician, Brillion Iron Works
Brillion, Wis.

IN ALL INDUSTRIAL Plants the Electrical Maintenance Department is literally the heart of the entire plant. Without a well-equipped and efficient electrical department considerable down-time and excessive overhead can be expected.

As a rule electrical trouble-shooting is spontaneous; a crane goes haywire or a cupola blower control system fails at a critical time. Invariably they are rush jobs that must be corrected with a minimum of delay as electrical failures in one machine alone can shut down a production line completely.

In order to keep machine downtime in line with present day standards of production, the following are *musts* in every electrical department.

1. Highly skilled electricians with a complete understanding of the machines and controls involved.

2. A suitable inventory of spare parts available on demand.

3. A well-equipped shop.

In discussing the need for skilled electricians there is a definite line to be drawn in the selection of these men. It is desirable from a standpoint of efficiency to maintain an electrical department composed of men who are skilled in their trade, dependable and above all who have the ability and desire to make constant improvements in the plant's electrical system.

It is no great accomplishment to be able to make needed repairs but he should be skilled enough to, in some cases, redesign control systems in order to eliminate weak spots.

I have seen electricians making the same repairs or adjustments day after day with never a thought of making a few changes in order to eliminate them for good. No matter who may have manufactured the product, in many cases weak points develop that can be eliminated with very few changes. This requires no engineering degree, only a complete understanding of how the controls work and what is expected of them.

Poorly-designed across-the-line starters or relays for example, can cause unending trouble in a control system, raising havoc with production in general.

It is the responsibility of the electrician to note these troublemakers and replace them with units of better design.

In discussing faulty controls; in the past few years there have appeared on the market several new lines of controls, most of them good but some not worth the powder to blow them up. A close inspection of these controls before installing will in some cases save many hours of needless trouble-shooting.

In order to make fast repairs it is necessary to know the *how* and *why* of the control system. The man who completely understands how the system works can in most cases analyze the trouble with a minimum of time and effort.

Inexperienced electricians or apprentices have their place in every electrical department and as a rule they are ambitious and eager to learn the trade from the bottom up. As mentioned in a previous paragraph there should be a definite line drawn as to how far the inexperienced man should be allowed to have serious responsibility in electrical maintenance.

In many instances serious harm has been done to equipment resulting from a lack of understanding of the controls. In one particular case, I saw a helper make a wrong connection on the control panel of a large honing machine and the results were disastrous, the control wiring burning up completely, laying the machine up for several hours.

This kind of maintenance does not promote good feelings between maintenance and management, but the entire blame cannot be placed on the shoulders of the electrical department. In many cases, management itself is to blame. Apparently it is the habit in many plants to employ a minimum of experienced electricians and thus provide an oversupply of helpers. This is false economy and shows a lack of understanding on the part of management of the problems and dangers involved in electrical maintenance.

In order to really have an effective maintenance department that can cope with present day standards of production it is necessary to have a workable system of preventive maintenance. The setting up of a preventive maintenance program and putting it into effect requires very little time and effort and it reduces down-time to a minimum with a corresponding upswing in production.

Getting into the habit of locating defective controls before a breakdown occurs is one of the first rules to observe. A monthly inspection of all electrical controls will drastically cut down emergency calls allowing more time to be put into general plant improvement.

The Brillion Iron Works instituted a system of preventive main-

MOTOR SERVICE RECORD

Mfg. ..... Kind ..... H. P. .....
Amps ..... Speed ..... Serial .....
Frame ..... Form ..... B.I.W. No. .....
Style ..... Type ..... Driving .....
Type Bearings ..... No. .....
Date Installed ..... Date Removed .....

Type of motor service record used at the Brillion Iron Works
(Above, Front)
(Right, Reverse)

Date	Repaired By	Remarks

with

FILMING AMINES

HERE'S AN exciting new development in the Water Conditioning Field!

Corrosion of steam and condensate return lines is a serious problem to most industrial plants. Such corrosion is caused by the presence of carbon dioxide and oxygen. Up to now, it has been the usual practice to neutralize the carbon dioxide. However, the high cost of this neutralization method has limited its application. And, no protection against oxygen corrosion is assured.

Betz Laboratories have developed a new, advanced process for the prevention of return line corrosion employing *octadecylamine*. This material *does not* neutralize the carbon dioxide. Instead, the amine is adsorbed on the metal surfaces in a monomolecular non-wettable film which acts as a barrier between the metal and the condensate, protecting against both oxygen and carbon dioxide attack. The monomolecular film does not increase in thickness with continued treatment. Results? As high as *99 percent reduction* in corrosion rate has been achieved!

Let a Betz Field Engineer show how you can cut costs in your plant with the use of filming amines. Write today! There's no obligation, of course. W. H. & L. D. BETZ, Gillingham & Worth Sts., Philadelphia 24, Pa. In Canada: BETZ Laboratories, Limited, Montreal 1.

Send for Betz Technical Paper #120, "How Filming Amines Prevent Steam and Return Line Corrosion".

[6] U. S. PATENT 2,460,259

BETZ

BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT

tenance a few years ago and the results have been gratifying. Control failures and motor burn-outs are the lowest that they have ever been. With this condition prevailing it has enabled the electrical department to make rapid strides in the over-all improvement of the plant's electrical system. The following gives a general idea of how our system operates.

1. A complete plant-wide inspection of all controls and motors once a month, any defective parts are replaced on the spot.

2. Lubrication of all motors once every three months, with a purging of all bearings once a year.

3. Blowing out motors every two weeks that are subject to extreme dusty conditions.

4. A complete overhaul of all motors once a year. This includes disassembling, washing out windings with carbon tetrachloride, painting windings and replacing all worn bearings.

In conjunction with this program a motor-service record file was set up. Each time a motor is torn down or one burns out, this information is written on the record card stating the date, repairman, and the reason for dismantling or the nature of the trouble.

The information so accumulated over a period of years has proved very enlightening as to the proper application of motors on individual installations. Excessive maintenance on a particular machine can thus be easily traced.

Don't Be a Genius

Oscar the Gas Works Owl hands out a bit of timely advice which stiffens a backbone and, incidentally, saves a 5000-kw turbine from a kind of mayhem

By JOHN RAVEN

ONE MORNING I came in about 10 o'clock after being up all night getting an overhauled turbine-generator ready to go back on the line, this being Founders' Day in the gas works, and the Boss didn't want us to be buying peak power from the electric company on the day the gas plant is a hundred years old. They are having the Mayor, and speeches, and what not, and I'm glad my work is under control, I think, when the telephone rings, and the Chief in Boiler House No. 2 greets me with this kind of trouble:

"John? Listen, you can't put that turbine-generator on the line because we ain't got enough steam. We busted a tube in No. 4 boiler, and now this here genius which the Big Bushwah discovered won't let us plug it. He says we gotta renew it with a concrete tube, like he once recommended on a beneficial suggestion that you turned down. Also, he says——"

"Genius?" I bellowed almost as loud as the Boss does when he's mad, "If you mean Rattle Head Smith, that screw-ball shift engineer, throw him out! Don't you know this is Founders' Day, and if that turbine doesn't start on schedule, we're mud?"

"John" she said, "I hate to deliver this, but—"

"I know," wailed the Chief, "But John, I can't throw him out. He says he's got more authority than you have, on account of his makin' genius in the Big Bushwah's intelligence test, while you barely made moron. If there's any throwin' out, you gotta do it."

I slammed the phone, grabbed a note from Oscar the Gas Works Owl I saw lying on my desk, and without taking time to read it, set out to manhandle Rattle Head Smith at once if not sooner. In the doorway, I was intercepted by the Boss' secretary, a gentle little thing, which is surprising in view of the boss she's got.

"John," she said sort of diffidently, "I hate to deliver this kind of message, but the Boss had to go to the dentist with a tooth ache, and he wasn't in a good humor. He said to tell you that the Vice President in Charge of Engineering is bringing down the whole senior class of the engineering college to watch you start the turbine, and if there is any hitch, you're never to darken his door again. I hope you're not mad."

"Mad?" I said. "Just wait 'til I get my hands on that Rattle Head Smith. If there's any hitch, he's it."

I pushed past her and ran right into Honest Melarkey, who should have been down at the river pump house, but wasn't.

"John," said Honest Melarkey, "this here genius Rattle Head Smith's ordered me to reverse the suction and discharge connections on the centrifugal pumps on account of the suction being bigger. He says

the bigger discharge will deliver more water. And John, you know that ain't right. Honest Melarkey won't do what ain't right. I'll quit first."

"Honest Melarkey," I said to him, "if you switch those connections, you won't need to quit. You'll be fired. Now get back to work."

Three steps farther and my course was blocked by Pipe Nose Henry, with a 12 in. stilson on his shoulder, and a trickle of worried sweat running right down his nose.

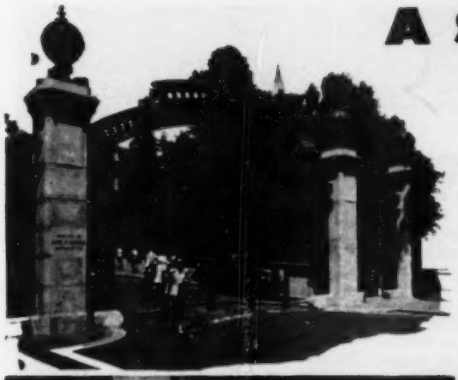
"Pipe Nose," I said, "if it's about Rattle Head Smith, forget him. He's crazy. Now go wash your face—the Mayor'll be here any minute."

"Thanks, John," he said, and smiled all over.

In the boiler house, I found Rattle Head Smith pacing the firing aisle, all dressed up in his Sunday clothes, and scowling through a pair of rich looking horn rimmed spectacles. To tell the truth, he looked more important than I did.

"Hah!" he sniffed, giving an ostentatious glance at his wrist watch. "Time you arrived. Don't you know I'm busy? This gas works needs lots of improvements. Lots of them."

"Rattle Head Smith," I yelled down at him, being about six inches taller, "if there's no steam to start that turbine I'll be fired. And I'm



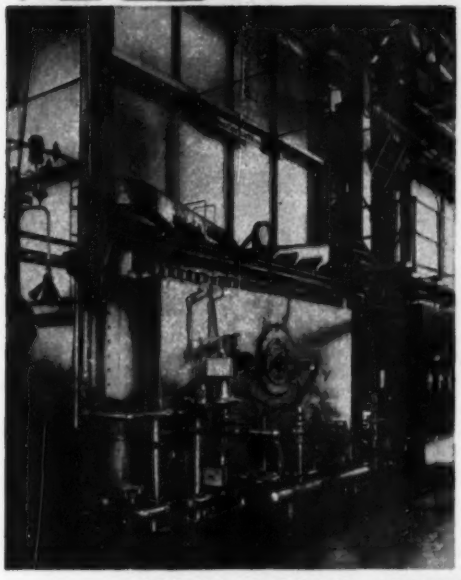
A STATE UNIVERSITY

Rates Its New . . .

ERIE CITY 3-DRUM BOILER

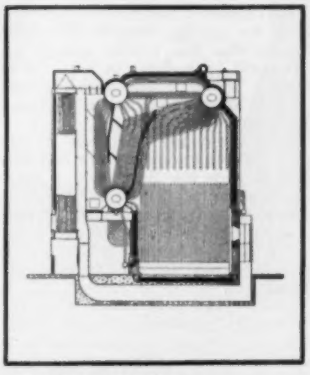
At

87.04% Efficiency



THIS type L Erie City oil fired 3-drum boiler complete with water wall cooling and air pre-heating has a nominal rating of 100,000 pounds of steam per hour and is designed to carry a heating load. It passed the acceptance test on Dec. 27, 1949, slightly better than predicted by Erie City engineers.

- Boiler Heating Surface . . . 9860 sq. ft.
- Water Wall Surface . . . 1260 sq. ft.
- Air Heater Surface . . . 7800 sq. ft.
- Furnace Volume . . . 4100 cu. ft.



STATE BOARD OBSERVES OFFICIAL TEST RUN

Boiler	Erie City Type L3-Drum	Fuel	Bunker "C" Oil.
Object of Test—		Percent CO_2	14.01
Determine capacity and efficiency of boiler.		Temperature gases leaving Boiler	599.2° F.
Date of Test	12-27-49	Temperature gases leaving Air Heater	375.7° F.
Steam Load	103,600 lbs. per hr.	Temperature air leaving Air Heater	355.4° F.
Pressure	133 p.s.i.(g)	Overall efficiency	87.04%

Installation and test under the supervision of Walter S. Leland Co.

Complete test data available upon request.

ERIE CITY

COMPLETE STEAM POWER PLANT EQUIPMENT

Complete Steam Generators • Type C 3-Drum Boilers • Type VL 2-Drum Boilers • The "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • Coal Pulverizers • Underfeed and Spreader Stokers • Welded Pressure Vessels for the Process Industries.

ERIE CITY IRON WORKS • ERIE, PA. • *Since 1840*

not going to be fired on account of you. If you're not out of this boiler house after I count three, I'll throw you out. Understand? One- two- "

I expected him to scurry away like a scared rabbit, because I've been his boss, at least until today, but he just folded his arms across his chest and looked up at me like a gas works Napoleon.

"John," he said, "if you lay one finger on me, just one, you'll be fired right now. The Boss told me so. I got authority."

That kind of checked me a little, and while I was wondering if I ought to say "three" and throw him out anyway, the Chief called me to the phone. It was the Boss, having come back from the dentist and learned from his secretary where to find me.

"John," came the familiar bellow that always set my ear drums back two inches, "if you're causing any trouble for Mr. Smith, you can stop it right now. I won't stand for it. Is that clear? I told him to do whatever he thinks should be done around this gas works, and you'll cooperate with him, or else. And another thing, if that turbine-generator's not on the line in an hour, don't come back."

Bang went the telephone at his end, and bang went my job just like that. I wish my Boss were a little less impetuous.

The Chief shook his head and said, "tsk, tsk, tsk," in worried sympathy, but Rattle Head Smith put on a smug look and addressed me thusly:

"John, since you heard what the Boss said, and admit you don't know how to start the turbine, kindly go over to the power house, and inform the superintendent I'll start the turbine myself. I know how. I'm a genius."

"You're nuts," I said, and headed back to the office, meaning to turn in my keys then and there. As Dignified Willy once said, being fired is an insult. I would quit first.

Half way to the office I remembered the note from Oscar the Gas Works Owl.

wen i was a yung oul (said Oscar's hen-tracks) i got so scard wen mice showd their teeth at me i almost starvd 2 deth b 4 i realized u cant give up easy in this world n live 2 now njuneers hoo quit wen the job gets tuf r startn a bad habit that can reck them in the end 4 ive seen it happn oscar th gas works oul hoo cs all n nos all

The Boss told me so. I got authority.

Well, I thought, Oscar is nuts too, because I'm not really quitting, I'm just avoiding being fired on account of not being able to start a turbine. Then I got to wondering how Rattle Head Smith could start a steam turbine without steam when I couldn't, and somehow I got turned around and headed for the power house.

About 300 students were jammed into the place, plus the gas works vice president in charge of engineering, and they were all talking at once. When I came in somebody said, "Make way for the starting engineer," and they gave a cheer. It was like a football game.

The superintendent was in a sweat about the steam situation, and when I whispered that Rattle Head Smith was coming in person to put the turbine on the line without steam, he turned white enough to faint.

"Good Lord, John," he whispered back, "I wouldn't trust Rattle Head to light off a match by himself, let alone put a 5000-kw turbine-generator on the line. Before all these people too. Is the Boss crazy?"

We heard some band music, and the Mayor, and the gas works president, and the Boss, and all the other big shots went past the windows in their automobiles, having a parade to the water gas house. I wondered if they had any girl majorettes leading the parade in white tights, and I guess the students wondered that too, because they showed signs of wanting to go out. They began to chant, "Start the turbine. Start the turbine."

The vice president said, "Can't we hurry this a little? There's lots doing here, today."

At that moment Rattle Head Smith came in, worming his way through the crowd and saying of all the silly things;

"Let genius through, gentlemen. Let genius through."

The students cheered. They thought it was a gag.

Rattle Head looked gravely at the turbine, saw that it was turning over on 50 pounds of steam for warming up, and nodded approval. Then he said to the students:

"Gentlemen, this turbine needs 250 pounds pressure for carrying a load, and only 50 pounds shows on the gage. Now watch the pressure gage, and you'll see genius produce the difference."

He wormed his way to a wall telephone, and a moment later the gage hand swung right up to 250 pounds.

The students cheered. Rattle Head Smith bowed. The vice-president in charge of engineering chortled, "great show, great show." The superintendent and I just stared at each other dumbly, thinking maybe he was a genius, after all.

I got so scared when mice showed their teeth—

"And now," said Rattle Head, beaming like a ham actor, "you'll see genius (myself that is) do something never done before." He motioned to the watch engineer at the turbine throttle and said, "when she's turning over at 600 rpm, let me know. Then we'll throw her on the line."

"Good Lord!" cried the superintendent, "No, Rattle Head, no! You'll burn her up!"

Somebody grabbed me by the arm to say I was wanted on the phone.

"John?" It was the Boss, and he sounded agitated no little. "John, what in hell are you doing to the steam? Somebody's cut off all steam to the water gas house. The president's here, and the Mayor, and nothing's running, and if it's your fault I'll kill you on sight!"

"Easy, Boss," I said, understanding now how Rattle Head had hiked the pressure to the turbine, "Smith did it to start the turbine. Now he's going to throw our 1800 rpm machine under load at ½ speed."

"Stop him," yelled the Boss. "Good Lord! Stop him!"

"Sorry," I said, feeling like the cat that swallowed the canary, "but you gave him the authority to do anything he wants. You'll have to stop him yourself."

I heard a groan, then a bang, and the telephone went dead. I didn't know if he had fainted or was just rushing over to the power house.

By that time Rattle Head Smith was ready to throw on the load: the tachometer was vibrating at 600 rpm.

"And now, gentlemen," he said, strutting like a rooster, "watch me, genius that I am, make history in the technique of putting a turbine generator on the line. One third speed I say, one third load. Watch ——"

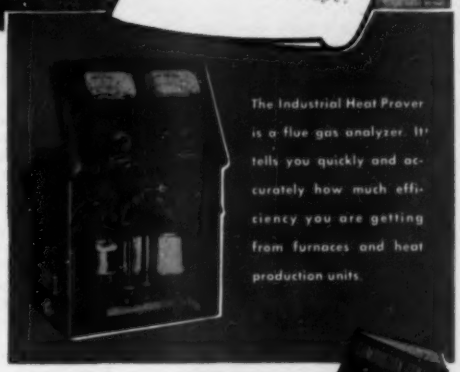
For one moment I considered letting nature take its course, then I reflected I ought to be fired if I let down the gas works and the Boss on Founders Day.

So, as Rattle Head Smith headed for the control panel, I yelled "Three!", having already counted one, two, in the boiler house. Then I just picked him up and carried his kicking and squawling 120 pounds

TO CORRECT
Combustion Losses...
Know the cause!
A TYPICAL EXPERIENCE
"We were baffled... until this amazing mechanical detective showed us how to step up power output!"
Midwest Plant Supt.

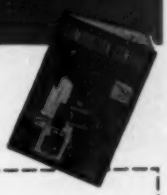
Rule-of-thumb methods in tracing causes of fuel waste and power loss have been made obsolete by the Cities Service Industrial Heat Prover. A recent case is typical: Heat was plainly being wasted; production was suffering, and routine "corrections" had failed. Then a Cities Service engineer was called in. As always, a Heat Prover test quickly supplied data on major combustion factors. The evidence pointed to outright heat leakage – confirmed by discovery of cracked brickwork. After repairs the average power output jumped 22%!

Similar contributions to production efficiency are reported often–because the reliability of Heat Prover combustion analysis makes it simpler to determine effective corrections. Ask about this service for your plant.



The Industrial Heat Prover is a flue gas analyzer. It tells you quickly and accurately how much efficiency you are getting from furnaces and heat production units.

FREE– Booklet completely describes the Cities Service Heat Prover. Mail coupon for your copy.



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Please send me without obligation your new booklet entitled "Combustion Control for Industry."

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*Company*_____

*Address*_____

*City*_____ *State*_____

to the power house door, and threw him out, Sunday suit and all, right at the feet of the onrushing Boss.

The students cheered and stamped, and the vice president smacked me on the back and said, "Great show, John. Great!"

The Boss then shook my hand and said,

"John, put that idiot back on a shift where somebody can watch him. And remind me to give you a raise, a good one."

As for Oscar, I staked out mice for him two nights in a row, and he didn't even leave their teeth.

PRACTICAL HINTS AND KINKS

WATER COLUMN PIPING GIVES TROUBLE

By H. D. FISHER

AN INTERESTING incident occurred recently during the starting up of a new boiler installation.

The boiler was of the three-drum, bent-tube type with partially water cooled furnace, rated 60,000 lb per hr and designed for steam at 200 psig and 100 F superheat. The boiler is fired with a spreader stoker.

To keep the lower water column connection below the upper walkway and also to avoid clean out doors and sootblower heads, the pipe was run with a somewhat deeper loop than usual, substantially as shown in Fig. 1.

When the water column was blown down with water level at the normal point the water went out of the glass and stayed out for an alarming length of time, returning eventually after perhaps 15 or 20 minutes to normal level.

The situation appeared still more puzzling because the boiler was equipped with a feedwater regulator which, except when the water column was blown down, maintained a very uniform level of water in the glass.

The first thought was of an obstruction in the lower water column connection which allowed the water level to equalize only very slowly but an inspection of the pipe eliminated that possibility because it was entirely clear.

A calculation, however, showed that if the amount of water disposed of in blowing down the water column amounted to less than would fill the vertical drop leg below the drum and the horizontal run front to the water column, the condition after blowing down would be that the vertical leg below the drum would be filled with water at a temperature of about 390 F having a specific gravity of 0.864 while the corresponding vertical leg at the water column would be filled with water at a considerably lower temperature. If this temperature (the pipes were not insulated) were 150 F the water in it would have a specific gravity of 0.980, and thus each foot of the hot water column would only counterbalance 10.58 in. in the cooler water column. Therefore, the level of water at the water glass would be 1.42 in. lower than in the boiler drum for each foot difference of level between the drum water level and the lower water column connecting pipe. Since this difference of level was 4 ft 11 in., the water in the water glass would show 7 inches below the drum level, which, in a glass 12 in. long with the normal level at the middle of the glass, would take it out of sight.

The disappearance of the water in the glass proved so annoying that the pipe to the lower water column connection was changed and located above the upper walkway so that its center line was about 2 ft 2 in. below the drum water line, being set out sideways to clear the cleaning doors, and 85 per cent magnesia insulation was applied to both upper and lower water column connections.

Since the difficulty with the water disappearing from the glass on blowing down the water column has not recurred since this piping change was made, it is considered that the explanation advanced herein is correct.

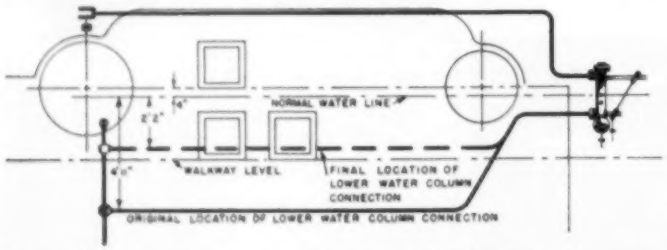


Diagram showing how the water column piping was originally installed and how it was rearranged to eliminate the trouble

WATER IN AIR COMPRESSOR CYLINDERS

By D. F. HERBERT

CONDITIONS of the Problem.

1. Water in substantial quantities in the compressed air system, including the compressor cylinders.
2. Time—10:30 a.m. Saturday—must start 6:00 a.m. Monday.
3. Master mechanic out of town on his vacation.

Things looked bad, particularly after a test of inter- and after-coolers and cylinder jackets showed no leaks at those points.

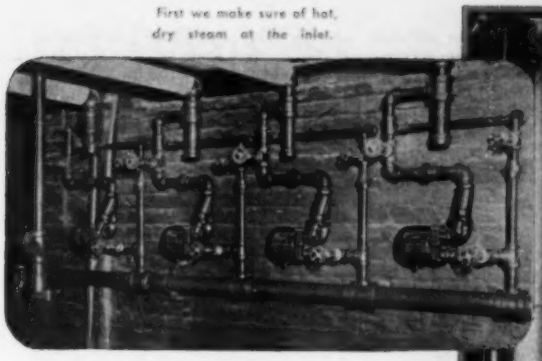
THE SOLUTION.

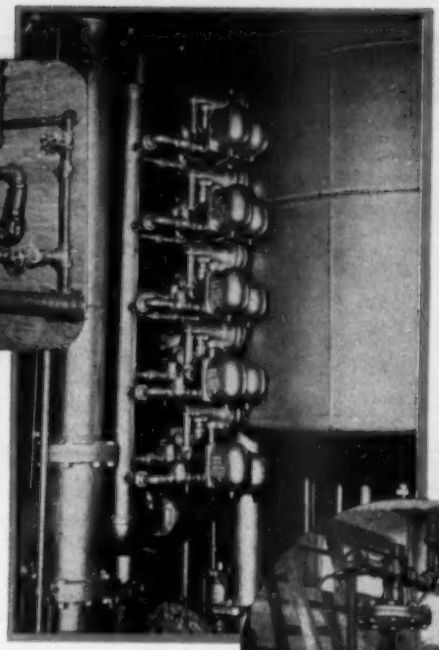
The air intake pipe draws outside air at an elevation of about twelve feet above the engine room floor, enters the engine room at that level, runs down the inside of the wall and across below the floor in fill (this is no basement) to the air compressors.

Close to it at one point is a small concrete lined catch basin into which various engine room drains empty. This catch basin has a drain to the city sewer, covered by a strainer. The concrete lining of the catch basin is old and cracked in several places.

The strainer of the catch basin drain had become clogged with mop ravelings, etc. and the water level in the catch basin had risen to about six inches below the floor. Apparently (it hasn't been dug up yet), this water had flooded the surrounding fill and entered the intake pipe (which may be up to 35 years old) through leaks, and was being aspirated into the compressors. Anyway, the catch basin strainer was cleaned,

First we make sure of hot, dry steam at the inlet.

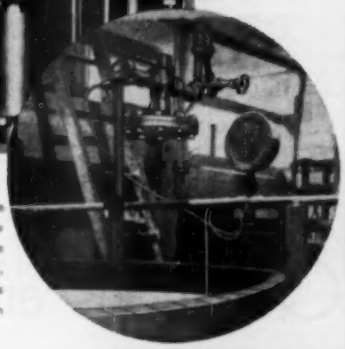




Then we select the best of four distinct types of steam traps to remove all condensate without steam waste.

GET YOUR STEAM SYSTEM *Rationalized* WITH SARCO

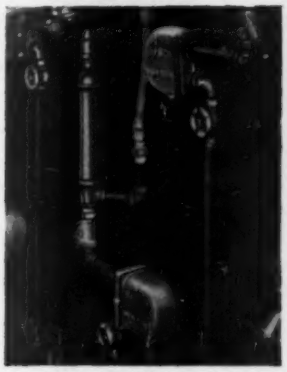
If automatic temperature control is indicated, Sarco can choose from a wide range of self-operated, pilot or electric controls to do the job at minimum cost.



Operating a steam process with maximum efficiency is more than buying a few steam traps and air vents—it is more than haphazardly applying a few temperature controls.

If it means dollars to you in increased production, improved quality and fewer rejects—it will pay you to let the Sarco man near you make a survey of your needs.

He will come up with definite, practical suggestions of how you can do a better job and save steam besides. Write today—there is no obligation.



The new Sarco draining and venting system for dry cans will save at least 20% warm-up time.

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SARCO SAVES STEAM

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IMPROVES PRODUCT QUALITY AND OUTPUT

the surrounding fill allowed to drain for a moderate time and one compressor started up carefully. No more than a normal amount of water appeared at the cooler and receiver drains and running the other compressor showed a similar result. The mystery was, therefore, considered solved.

THE REMEDY

To prevent recurrence a masonry lined trench with cover plates and proper drainage will be installed for the air intake pipe. In this way the pipe may be inspected and painted when necessary.

HANDY WRENCH GIVES FINGER-TIP CONTROL

By JAMES BOYD

MANY JOB operations are made difficult to perform due to the worker's inability to place, hold or tighten nuts in out-of-the-way or out-of-sight locations. Often, under such conditions, the worker is forced to completely disassemble confining parts in the working area before he is able to proceed with his job.

However, there is a new tool on the market which is called the "Touch N Grip Finger Tip Wrench" that makes some of these difficult jobs easy to perform. The accompanying illustration shows the simplicity of this new tool. The wrench slips over the end of finger and is worn like a thimble and does not limit the use of the hands. Once in proper position, the wrench picks up the nut in its hexagonal opening and

Finger-tip wrench makes it easy to place and tighten nuts located in out-of-the-way places

then goes to work doing the job with finger-tip control.

These handy new wrenches are formed from steel and are nickel plated. They are supplied in sets of four to fit ¼", 5/16", 11/32", and ⅜", and they may be adjusted to fit any finger.

Questions and Answers

Question No. 469

HOW CAN HE FIND GROUNDS ON A 32-V CIRCUIT?

WHAT IS the best method of locating grounds on a 32-v light and power circuit?

Ordinarily we use voltmeters to check grounds and find this method fairly satisfactory. A megger, of course, reads grounds that would not bother a 32-v system, but such circuits are generally too large for an ohmmeter.

I have noticed, however, that your readers come up with some pretty novel and effective ideas and I am looking for one of those.

Wilmington, N. C. D. H. N.

Question No. 470

SHOULD HE PUT FURNACE BAFFLE IN OIL-FIRED SCOTCH BOILER?

WE HAVE 150-hp Scotch marine type boilers in this office building power plant, supplying steam at 8 psig for the building heating system.

We burn in these boilers an oil that we are told is somewhere between No. 5 and No. 6 in character, using mechanical atomizing (rotary cup) oil burners.

Would the installation of a small perforated baffle on the bottom of the Morrison furnace of these boilers improve combustion and save any fuel? I used such baffles in similar Scotch boilers where I was previously employed, and believe they improved combustion and reduced fuel consumption, although we made other changes at the time we installed the baffles and consequently do not know whether they alone caused the resulting decrease in fuel consumption.

I would like to get the ideas of Q & A readers about the use of such a baffle.

Chicago, Ill. J. B.

Question No. 471

SHOULD THE SUCTION PRESSURE COME DOWN TO ZERO ON THIS CO_2 COMPRESSOR?

ON OUR 120-ton CO_2 refrigeration compressor, while it is in operation, the suction gage registers 450 psi and the discharge gage 950 psi. In shutting down the compressor, I close the expansion valve, then the pointer on the suction gage comes down to 200 lb; then I close the suction valve slowly and the pointer comes down to 100 lb and no farther, and I stop the compressor. Should the gage reading come down to zero?

After the compressor is stopped, I immediately start to close the discharge valve, but while I am closing it, the suction gage pointer starts to go up again to 350 lb. As soon as I close the discharge valve tight, the pointer on the high side gage comes down and equalizes with the suction gage at 350 lb.

While the machine is stopped, two days later the pointer on both gages has equalized, rising to 700 psi. I can find no leaks.

The water going into the condenser is 45 F and the water going out is 58 F. The condenser acts as a receiver. There is a by-pass valve but no pump-out valve.

The compressor is driven by a 327-hp synchronous motor, using a 3-hp exciter, the ammeter set for 21 amp.

The compressor cylinder has been bored out and new rings have been put on the piston and the bearings re-babbitted, but nothing done to the valves. There are two-port valves, one on each cylinder on the back.

Why is it that I have to take a crowbar to put the compressor on center first, or else it will not start? Sometimes the fuse burns out.

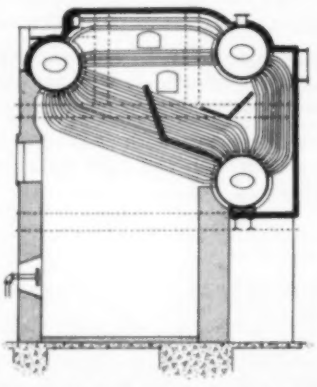
Jersey City, N. J. E. B.

Answer No. 463

SHOULD HE WASH FIRE SIDES OF THIS WATER-TUBE BOILER?

WE HAVE Type C, 3-drum boilers as shown in the sketch, said C. B., June issue, and are wondering if we can wash the outside of the tubes with water, which we understand is quite common practice. The boilers are fired with by-products of our lube oil plant. These contain salts and dirt, which leave a heavy deposit on outside of tubes. Internal boiler surfaces do not require cleaning.

Would tube washing damage the settings or the baffles? Should the boilers be allowed to cool before washing? With the baffle as shown, there is a pocket where the baffle



Section of 3-drum boiler by C. B. showing baffle, which would form pocket and catch dirt from washing tubes

BIDDLE
Instrument News

• ELECTRICAL TESTING INSTRUMENTS
• SPEED MEASURING INSTRUMENTS
• LABORATORY & SCIENTIFIC EQUIPMENT

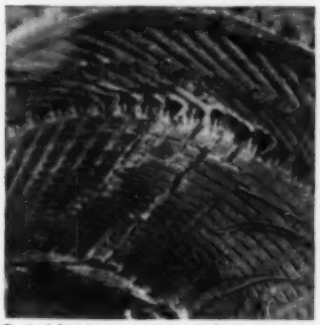
NUMBER 2 OF A SERIES

JAMES G. BIDDLE CO., 1316 ARCH ST., PHILADELPHIA 7, PA.

REDUCE ELECTRICAL BREAKDOWNS IN YOUR PLANT with a Regular Schedule of INSULATION RESISTANCE TESTS

Irwin Robbins, Electrical Engineer, Factory Mutual Engineering Division writes in a recent article in PLANT ENGINEERING:

"The greatest single cause of electrical machinery breakdown is the failure of the insulation. Despite improvements in insulating materials in the past decade, insulation is still the most vulnerable part of an electrical machine . . ."



Typical damage to generator windings

It naturally follows that a regular program of checking the condition of electrical insulation pays off. Much can be saved in prevention of motor damage, wasted current, loss of production and *danger* to life and property.

For more than a half century the Megger Insulation Tester has been a highly effective means for testing any type of electrical equipment, whether a-c or d-c and irrespective of the voltage rating of the apparatus. It is direct-reading, easy to use and has its own source of power. It permits non-destructive tests which disclose incipient insulation weaknesses, rather than merely signaling insulation breakdown that has already occurred.

A series of periodic tests recorded on charts supplied with each Megger set assures you that the insulation of a machine is holding up . . . or warns you that insulation is becoming weaker and conditions should be investigated.

Most Trouble is Caused by Dirt or Moisture

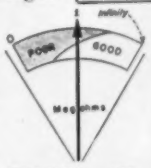
It is more economical to blow out dust, dry out coil windings, eliminate oil conditions, or even replace a motor or generator on off-hours *at the convenience* of the production and maintenance departments—than to have trouble strike unexpectedly and production interrupted indefinitely.

The story of electrical insulation resistance is told in our easy-to-read booklet entitled "For Practical Men." Most maintenance men, who have seen it, have requested extra copies for their associates. *Yours* will be mailed free of charge by simply requesting Bulletin 21P8-PE.

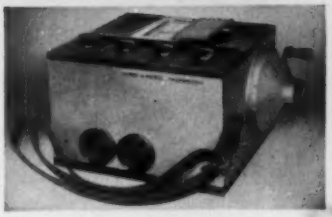
GETTING THE MOST FROM INSULATION RESISTANCE MEASUREMENTS . . .

Interpreting Results When Time and Test Voltage are Changed

Electrical men agree that the accepted method of determining whether insulation is healthy is by measuring its resistance. Megger Insulation Testers have long been the popular choice of men charged with the responsibility of electrical maintenance. These men recognize the importance of the proper analysis of the readings they obtain with their Megger instruments. The best thinking of men who know is available in Biddle literature on the subject. For our latest publication on electrical insulation resistance, "For Practical Men", just write to us at the address above and we will mail it at no obligation. Many who have already read this helpful booklet are requesting additional copies for their departments. Ask for Bulletin 21P8-PE.



ONE MEGOHM per 1000 v is still a good practical guide



ONE INSTRUMENT FOR PRACTICALLY EVERY ELECTRICAL RESISTANCE MEASUREMENT

Bridge-Meg Measures a Fraction of an ohm up to 1000 megohms—Wheatstone Bridge Included—Varley Loop Optional

Wherever insulation resistance tests are made, wherever a Wheatstone bridge is needed, this instrument, with its hand-cranked, constant voltage generator is always ready for detecting, diagnosing, and locating electrical faults. Weighing only 15 pounds, this multi-purpose test set is an ideal field tool which quickly pays for itself over and over again.

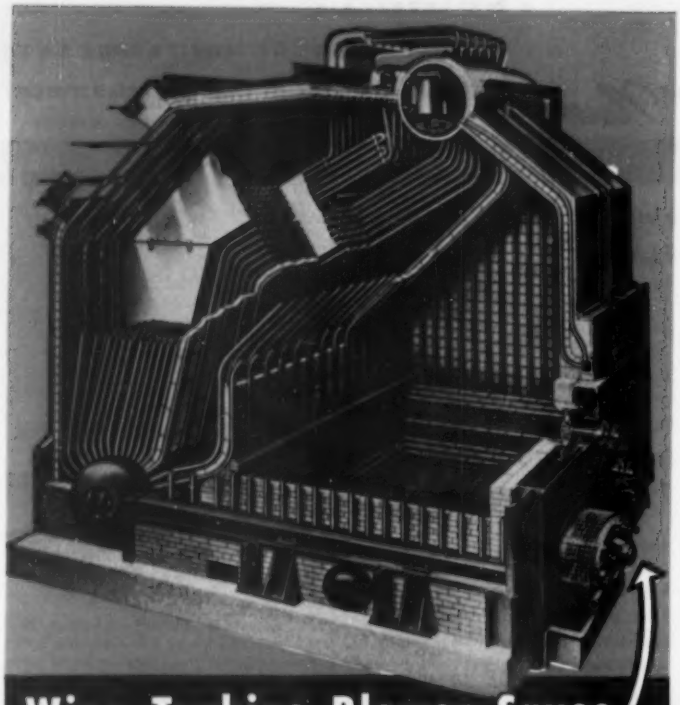
The Wheatstone bridge is particularly useful in connection with measurements of all manner of coils, resistors and circuits.

The Varley Loop makes possible the location of faults on wires in telephone, telegraph, signal and electrical power systems in industrial plants and power companies.

Electrical modernization programs should include modern measurement and test methods. You should have complete information on this versatile Bridge-Meg Resistance Test Set.

Write for Bulletin 21-60-PE.

We are constantly publishing new technical bulletins on Biddle Instruments. A complete list of our latest bulletins will be mailed you on request, so that you may check it to bring your files up to date.



Wing Turbine Blower Saves Floor Space, too

Besides furnishing forced draft with precise control, the Wing Turbine Blower contributes to the cost-saving features of the B & W Integral Furnace Boiler, illustrated above, by saving valuable floor space, avoiding duct work and large space requirements. It is also quiet and efficient in operation.

A copy of Wing Bulletin No. SW-50 on Wing Blowers and Turbines will be sent on request.

L. J. Wing Mfg. Co.
64 Vreeland Mills Road
Linden, N. J.
Canadian Factory: Montreal

Wing

AXIAL FLOW BLOWERS

meets the bottom drum. In washing tubes, water and dirt would be washed into this pocket. How would we get them out?

Yes, Deposits Are Soluble, says Biggs

QUESTION:—Should he wash fire sides of this water tube boiler? Answer:—Yes.

The substance on these tubes is solvent in water and they can be washed clean in about three to four hours by using a very small stream of water, playing the water on the top tubes first and letting it trickle down over the other tubes. I have been following this method of cleaning boilers, air preheaters and economizers since the year 1912 and have never noticed any damage to be done to the boiler setting.

It is not necessary to use a large quantity of water, but by playing a small stream upon the tubes for three or four hours it will loosen soot and scale and other matter deposited upon the tubes. It is the easiest and most effective way of cleaning the outside of boiler tubes, economizers and either tubular or regenerative type air preheaters.

Peoria, Ill. W. F. BIGGS

Yes, Wash, says Freyberg, with Special Provisions on Brickwork and Baffles

C.B. MAY BE ABLE to wash his fire sides free of the scale and dirt without any particular precautions beforehand. However, he should analyze the material before washing, to confirm its solubility. Most of these deposits have a sufficient percentage of solubles, so that the insolubles are loosened and can be washed away by the volume of the washing water. Usually solubility is best in 130-F water or higher, and the addition of alkaline material to the solution also increases solubility of the deposits.

A number of articles and papers have been written in technical publications in the past year or so about prevention of such formations, and also about the control of deposition by cleaning with a soda ash wash (to get down to bare metal) followed by the application of a heavy lime slurry to which the material is supposed to cling less tenaciously. See *Power Generation*, July, 1949 issue, page 74.

One plant with which I have been associated tried the method without very conclusive results. Other public utilities with which I have corresponded on the subject would not be without the procedure. There is no doubt about the cleaning ability of the soda ash solution, however. That is good.

The boiler C.B. has in his care appears to have considerable brickwork, which would crack and chip if subjected to relatively cold water soon after taking the boiler off-line. The cooler the boiler the better, of course, but usually 16 hr or so of no fire with setting doors open and

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Sustained high torque from starting to maximum speed — that's typical of the exceptional flexibility that can be achieved with Troy Steam Engines. Speed can be varied smoothly, quickly, without complex auxiliaries. Or constant speed can be maintained with the Type EN Governor — which can be instantly adjusted manually or automatically over a speed range as great as 6 to 1!
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From floating on the line to full steaming: Wide speed range and smooth power, combined with year-after-year dependability, make a Troy Steam Engine the logical drive for a chain grate stoker, as in this installation at Children's Memorial Hospital, Chicago.

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If your drive needs any or all of these five characteristics, the modern Troy Steam Engine is indicated. Send us your drive requirements and steam conditions, and our engineers will be glad to recommend the right type and size Troy engine to meet your needs.

TROY

Send for Bulletin 306

Troy Engine & Machine Co.

Power Equipment Division

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some fan circulation through the furnace and gas passes should cool them sufficiently to permit his men to work freely.

We found it to our advantage to spread canvas over the arch and the floor, and guide the water by such canvas to drains — openings in the floor brick which were covered temporarily by fire-brick during boiler operation. You cannot catch it all, but we found no serious damage from what little ran down the walls and missed the canvas.

The best way to handle the baffle tile situation is to remove a course or two of it at the lowest point and wash freely to clear the mud out. From the locations of these baffles it appears that C.B. cannot do this, but there is a chance he can get at the ends and wash thoroughly from one end toward the other. He is right that if he doesn't figure out a way to get the passage clear for wash water to go through, he will have mud accumulate and harden into something worse than present deposits.

Pleasantville, N. Y. RICHARD H. FREYBERG

Wash Tubes OK — First Cool Boiler, Protect Refractories, says Poor

IN MANY CASES, it is simpler and easier to clean external boiler heating surfaces with hand lances or rods than to use water. However, in the case of oil firing (particularly with poor oil) there is often a deposit which is not easily removed mechanically, but which is water-soluble (or with a water-soluble binder) and can readily be removed by water washing. Precautions must be taken to protect the metal parts of the boiler and the refractory of the baffles and setting when this is done.

It is usually easiest to wash the boiler when it is at room temperature. The temperature of the wash water should be near that of the metal parts to prevent setting up differential expansion stresses due to temperature differences. The external deposits are acidic and form a corrosive solution in water; for this reason pockets of water must not be left in contact with metal for an extended period.

The washing should be done, therefore, near the end of an outage, so that as soon as the cleaning is ended a fire can be started to heat up the unit and dry it out thoroughly; dry deposits will not attack the metal. Use of alkali wash water is unnecessary and in general is ineffective, because, in remote corners where a small amount of water penetrates carrying a small amount of alkali, there may well be much more than enough acidic deposit to neutralize the small amount of wash water. Use of alkali water probably does more harm by generating too much false confidence than it does good; drying out is the safest procedure.

To protect the brickwork, the minimum amount of water should be

SLUDGE OR SCALE?

There's no place for guesswork in boiler rooms. Scale and adherent sludge cause tube metal to overheat and fail. They often look alike—yet the cause and cure of each may be entirely different. Someone *has* to know this difference or your water treatment may fail.

*Sludge,** a water-formed sedimentary deposit, may include all suspended solids in the water. "Baked-on" sludge is hard and adherent, similar to scale.

*Scale** usually forms from solution directly in place on the surface. It is crystalline and dense in nature.

The Drew System of Water Treatment eliminates guesswork! It starts with proper diagnosis. Corrective treatment, modification of operating cycles, redesign of equipment and other preventive measures are recommended when required. The Drew System is more than superficial service . . . more than chemical "prescriptions" . . . it is specialized service, corrective treatment and preventive measures applied to your individual boiler problem.

*Brief ASTM definition. Send for additional information on the cause and cure of sludge, scale or other water problems.

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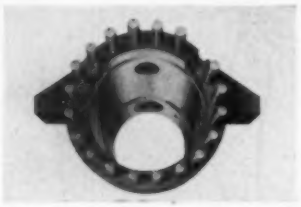
Here's how your high pressure Boiler Feed Pump is Precision Built by Pacific

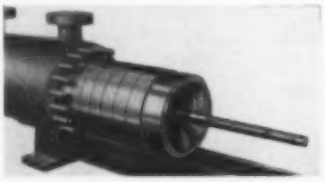
1 The steel forging for the outer case is thoroughly annealed.



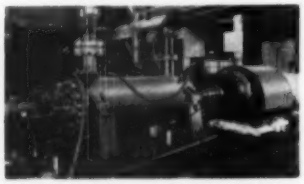
2 The outer case is precision finished.

3 The diffusers and impellers are chrome alloy steel—impellers dynamically balanced.

4 The unitized internal assembly is assembled outside the case. All parts are precision finished.



5 The unitized internal assembly is installed in the outer case.



6 The pump is completely assembled—then performance tested.

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8 A precision-built, performance-tested, inspected Pacific Pump is on its way!

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Bulletin 109 Gives Details

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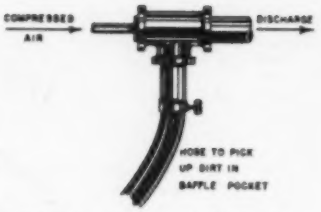


Detail of aspirator suggested by Poor

allowed to reach the walls and floor. It is usually possible to rig tarpaulins as curtains and drain troughs in such fashion that the bulk of the water can be drained off without soaking the brickwork.

When the unit is fired up for drying out, it is important to fire up slowly and allow the brickwork to heat up gradually, so that there is no possibility of flashing into steam any of the water that has penetrated into the refractory or the masonry joints.

Water and dirt could be removed from the pocket between the baffle and the lower drum by connecting a strong aspirator or ejector onto one end of a compressed air hose and inserting the other end, extended with a pipe if necessary, between the tubes and into the pocket to suck it empty. It might be found easier to cut a drain hole in the baffle at the drum and plug it up before the boiler is returned to service.

Water washing is a safe and useful procedure if the proper precautions are followed.

New York, N. Y. HUSTACE H. POOR

Armstrong's Experience in Washing Down Firesides of Boiler

WE HAD TWO 15,000 lb per hr two-drum package boilers, which were in operation for three years at our plant before being sold, due to expansion of the plant.

Within two hours after taking the boiler off line, we would rinse *all* the tubes, including firebox and water wall tubes. We used our treated water from the feedwater pump which produces about 80 psi and water at 210 F. The dirt and deposits on tubes and setting would settle to our combustion chamber and then could be removed.

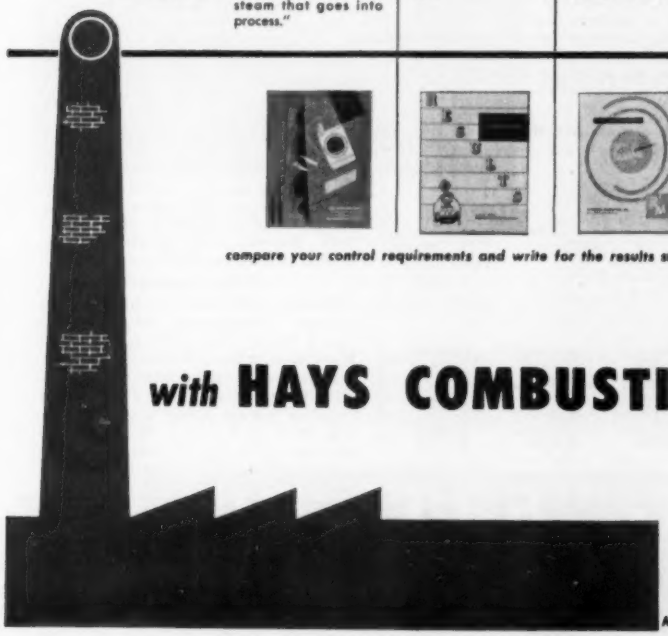
When the boilers were sold, the buyer had a State inspector inspect the boilers. He reported that the boilers were in excellent condition as far as the brickwork, settings, baffles, and so on were concerned.

As to the pockets in your boiler holding dirt, I feel it would be worth while to install access doors or openings at this spot, whether you use water or not. This dead spot should eventually need cleaning out.

Our new boilers are only a year old and we have already added a new clean-out door.

Sheffield Lake, Ohio F. G. ARMSTRONG

these leading companies	AMERICAN TOBACCO COMPANY	SHERWIN-WILLIAMS COMPANY	RAYBESTOS-MANHATTAN —COMPANY	BEMIS BROS. BAG COMPANY	SUNSHINE BISCUIT COMPANY
with these conditions — no. of boilers	Three (one stand-by)	Three	Four	Two	One, plus steam generator incinerator
with these conditions — rating	16,500 lb per hr	65,000 lb per hr	19,650 lb per hr	70,000 lb per hr and 80,000 lb per hr	31,500 lb per hr
with these conditions — load	Varies from 40-50,000 lb per hr total fluctuation up to 20,000 lb per hr	75,000 max. each boiler	120,000 lb per hr in winter—70,000 lb per hr in summer	68,000 lb per hr in winter, 60,000 lb per hr in summer. Daily variation 15,000 lb per hr	From 10,000 to 30,000 lb per hr
with these conditions — fuel	Coal	Coal	Coal	Oil and coal	Oil
with these conditions — use of steam	Power and process	Process and space heating	Mostly for process, also for pumps, compressors and heating	Power, process and heating	Process
and these problems	1. To recondition or add new boiler 2. Better process load regulation	Combustion efficiency	To get better efficiency. To get more out of boilers due to rising load	Accurate control of pulverized coal and oil firing through wide load swings	To lower costs. Drastic load fluctuations
got these *results*	(1) "The Hays instruments and controls, through greater efficiency . . . gave us the solution . . . that of increasing steam capacity" and (2) "regulating the steam that goes into process."	"Operating efficiency has been as high as 82%—much of the credit going to the accuracy of (Hays) automatically controlled combustion."	"Our basic reason for installing the Hays control was to obtain better efficiencies. Our aim was more than reached . . . efficiency . . . 79.3%."	"We have made test runs using the Hays automatic combustion control system, bringing the load rapidly up from 8,000 lb per hr to 80,000 lb per hr with excellent results."	"Our management and operating crew are well pleased with the new (Hays) unit, not only because of the low maintenance costs but also because the equipment enables us to keep close watch over our operating costs."



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Steam and Power for A. B. Dick Co.'s New Plant

By F. R. MALMGREN
Staff Assistant, Construction and Maintenance
A. B. Dick Co.

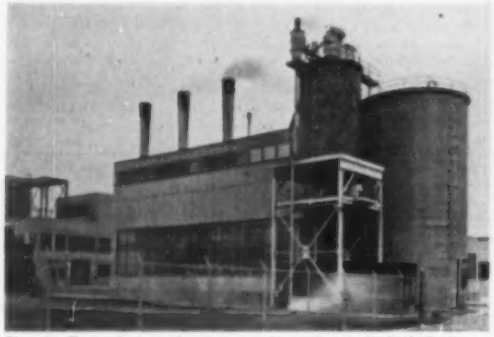


Fig. 1. General view of new power house for A. B. Dick Co.'s new plant at Niles, Ill., showing coal and ash silos. Asbestos wall construction, roof of precast concrete, fiberglas insulation

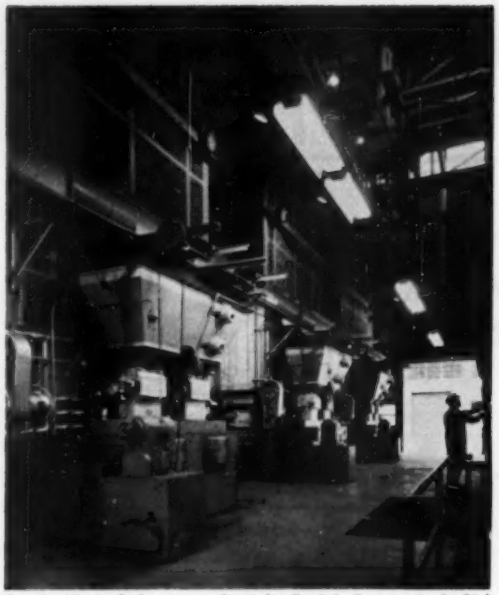
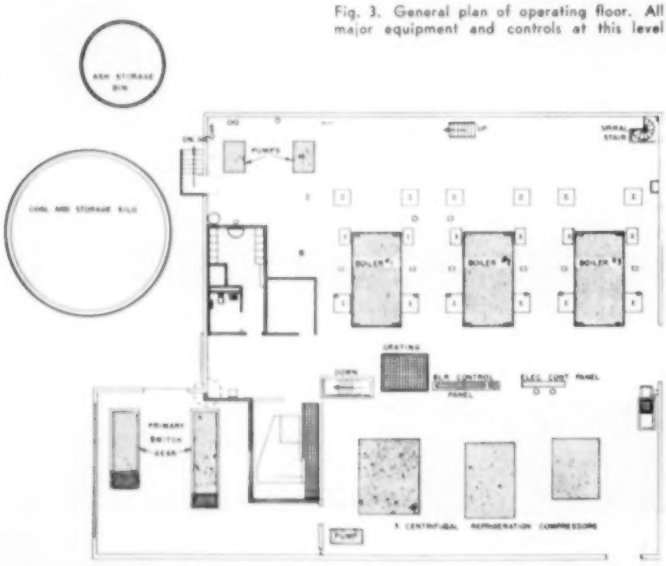


Fig. 2. View of three spreader-stoker-fired boilers in A. B. Dick power house. Note fluorescent lighting in this room and screw conveyor above stoker hoppers

TO SUPPLY process steam, electricity, refrigeration for air conditioning and other power services to the new $8,000,000 mimeograph manufacturing plant completed in October 1949 by A. B. Dick Co. at Niles, Illinois, the power house shown here was built as an important component of this modern development.

This new manufacturing plant, 16 miles from Chicago's loop, consists of a one story main manufacturing building covering 454,000 sq ft and housing all production facilities, a two-story, 100,000 sq ft office building, a solvent recovery building, a pump house, an oil storage building and a power plant. These consolidate all activities formerly carried on in two separate multi-story buildings in Chicago.

Fig. 3. General plan of operating floor. All major equipment and controls at this level



Steam Generation

The power plant supplies the new office and manufacturing plant with steam generated at 125 psi by three water-tube boilers of 25,000 lb per hr capacity each. Each boiler is fired by a spreader stoker of the continuous ash discharge type, Fig. 1, or by two gas burners set in the rear furnace wall, Fig. 5. The units are designed to burn Illinois and Indiana coal during the months from October to April, when there may be restrictions on the use of gas; and to burn the gas the rest of the time. Conversion to gas burners requires only the covering of the stoker grates with firebrick.

Coal Handling

Coal is delivered to the plant in hopper bottom cars, which dump into a track hopper, whence the coal travels on a bucket conveyor over a magnetic separator and up to the top of a 700-ton storage silo, Fig. 1. From the live storage space above a sloping shelf in the silo, the coal discharges to a screw conveyor that conveys the coal into the boiler room where it dumps into the stoker hoppers as shown in Fig. 2. High and low levels of coal in the hoppers are controlled by a coal level control device that automatically starts and stops the screw conveyor.

Ashes are removed from the stoker hoppers by a pneumatic ash handling system that also picks up the fly ash from the dust collectors and siftings hoppers and delivers it

The TERRY TURBINE

TURBINES FOR *Air Conditioning* AT MADISON SQUARE GARDEN

In 1925 Madison Square Garden installed three Terry Multi-Stage Turbines to drive air conditioning and refrigeration compressors. These units deliver 290 hp at 3500 rpm with steam conditions of 100 psi exhausting to a 26 in. vacuum.

After 22 years experience Madison Square Garden installed three more Terry Multi-Stage Turbines, one of which is shown above. This unit delivers 330 hp, at 5650 rpm, with steam at 100 psi exhausting to a 25 in. vacuum.

The same engineering talent and manufacturing facilities that produced these turbines are available to assist you in obtaining efficient power generation.

Any of our District Representatives will be pleased to give you full information on a turbine drive for your requirements. No obligation. May we send you descriptive bulletin?

TT 1164

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

to the 75-ton ash storage silo, Fig. 1, adjacent to the coal silo. The ash silo unloads ash to railroad cars or trucks for disposal.

Steam generated at 125 psi is reduced as required for process work and heating at local stations. Boiler operations are under automatic control from a panel board, Fig. 6, which carries steam flow meters, CO_2, feedwater and steam recorders, water level indicators, smoke alarms and flame failure controls for the gas burners. Every attempt has been made to install safety devices that will warn the operators if equipment is not operating properly. Each boiler has both forced and induced draft fans.

Water is purchased from an adjacent suburb, which in turn draws it from Lake Michigan. No attempt is made to store water except for fire protection purposes. A 100,000-gal watersphere type tank is utilized for that purpose.

Refrigeration

Refrigeration is required in certain process operations as well as for office air conditioning. Control of temperature and humidity is quite important in the manufacture of stencil sheets and this is a year round operation. The company had one centrifugal refrigerating unit it was able to move out from the old location and two additional machines were purchased and installed. One machine is designated as the office machine and the two others are for process areas. All the machines are cross-connected, however, to enable one or two machines to carry light loads. A total of 1000 tons of refrigeration is available.

Cooling water is supplied by a cooling tower located just outside the boiler house.

Electric Power Supply

Because this plant is located out in open country and electricity is supplied by overhead lines, it was deemed advisable to bring in power from two directions, although the common source is the Public Service Co. of Northern Illinois. In the event of a sleet storm causing a failure in one line, the other line may be utilized within a few minutes. Power is delivered at 33,000 v, 3-phase, 60 cycles to the Public Service Co.'s substation, which has one 5000-kva, 3-phase transformer. Provisions have been made for doubling the present capacity.

Voltage of 4160 is provided to the main switch gear room in the boiler house. There are four smaller unit substations located in the plant, where the voltage is reduced to 480 v, 3-phase for power and 120-208 v, 3-phase, solid neutral, for lighting. Dry-type transformers are used in these substations. Office building power is derived from a unit substation in the manufacturing building. A separate transformer in the office building is provided for lighting where the 4160 volts is reduced to 120-208 for lighting. Overhead bus duct is used wherever possible for machine power.

The Austin Co. engineered and built the entire new plant at Niles, including the power house, working closely with A. B. Dick Co. engineers to incorporate their ideas into the new structures. Frank Donner is chief engineer in the new power plant.

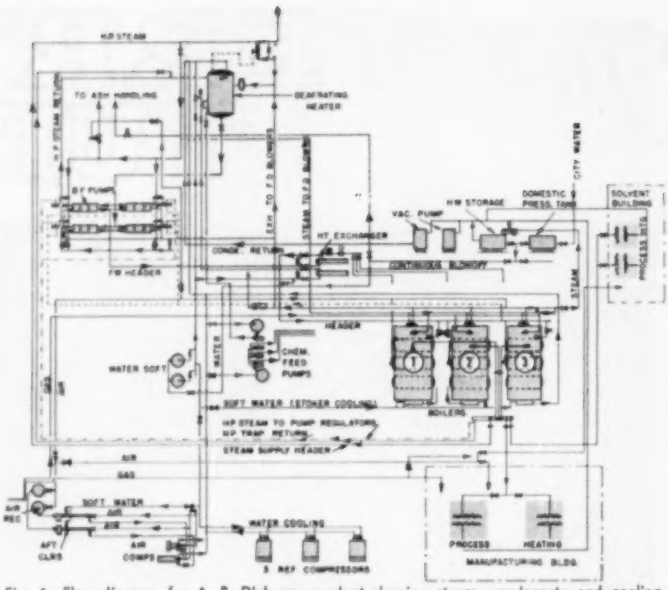


Fig. 4. Flow diagram for A. B. Dick power plant showing steam, condensate and cooling water flows

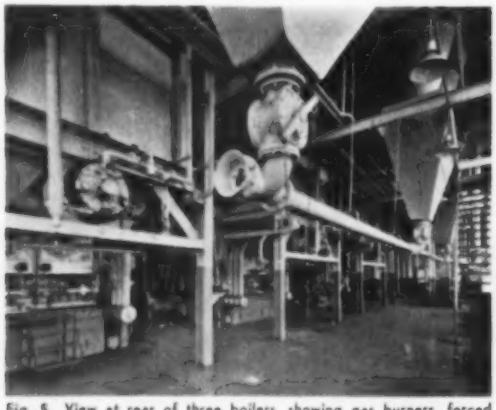


Fig. 5. View at rear of three boilers, showing gas burners, forced draft blowers, fly ash collectors. Note open design with plenty of working space, good daylight and attractive color scheme

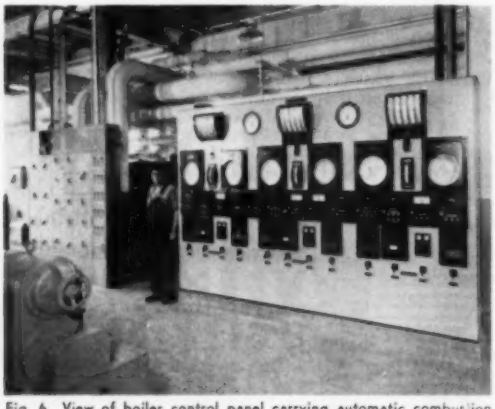


Fig. 6. View of boiler control panel carrying automatic combustion control and instruments. At left, electrical control panels for power house and plant electrical circuits

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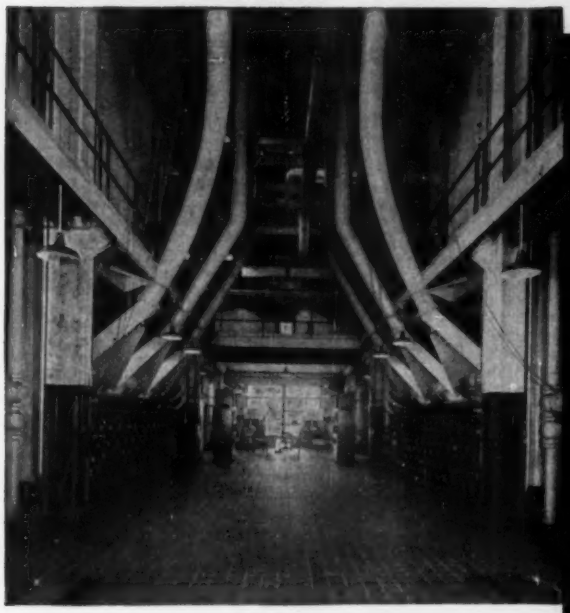

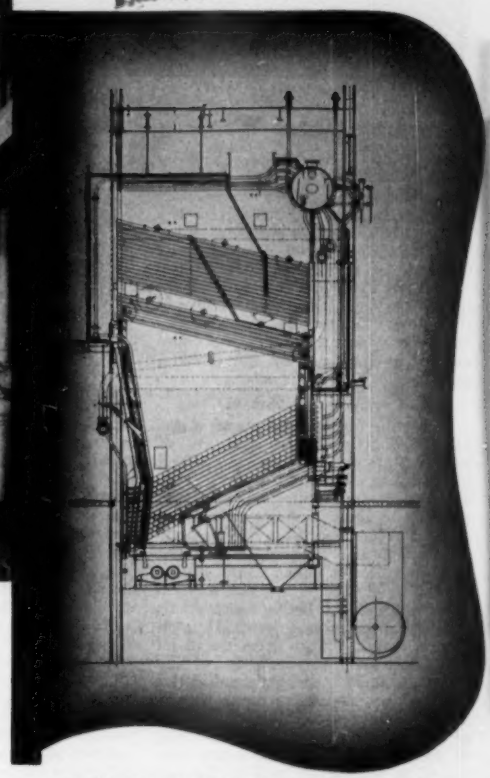

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Vogt FORGED STEEL SECTIONAL HEADER

STEAM GENERATORS

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Principal Data, Each Unit

220,000 pounds steam per hour capacity Steam and water drum is fusion welded and designed for 400 pounds S.W.P. Sinuous forged steel tube headers. Water cooled furnace walls.

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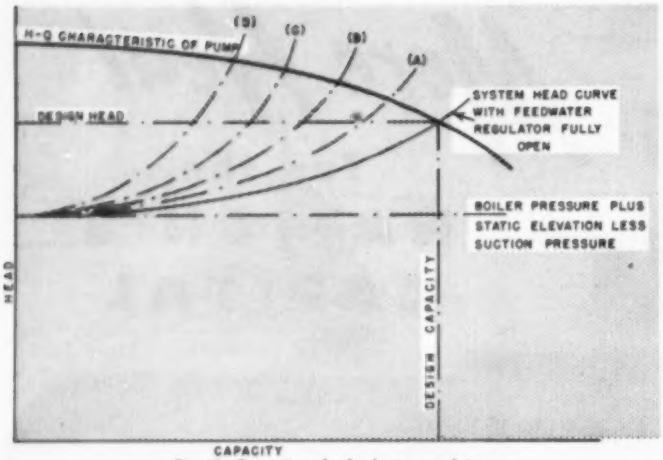

Fig. 15. Operation of a feedwater regulator

CENTRIFUGAL BOILER FEED PUMPS

(Continued from page 67)

Actually, one must remember realistically that the suction piping is generally from one to two sizes larger than the suction nozzle, therefore the use of this or that size decreaser at the suction is of no particular matter. It is the areas inside the pump that count—not the dimensions where the pump is permanently hooked on to the suction piping.

Suction Problems for Special Cases

While the foregoing discussion applies primarily to the majority of installations where the boiler feed pump takes its suction directly from a direct-contact heater, it holds just as well in such systems where no direct heaters are used, as illustrated in Fig. 10. This represents the so-called "closed" feed cycle, where several feed pumps are operated in series with closed heaters interposed between successive pumps. In such a case, the discharge pressure of all pumps must be carefully established, so that at no time could the suction pressure of the pump immediately following fall below the sum of the vapor pressure corresponding to the maximum temperature obtained at the heater and of the required net positive suction head. Under normal conditions this is not difficult to attain.

However, great care must be taken in the event one or more of the low-pressure pumps are operated at variable speed. The controlling factor for this speed variation is the flow to the boiler and the controlling mechanism either an excess pressure or a constant pressure regulator which varies the speed of the centrifugal pump in question. The latter may be driven by a steam turbine, a wound-rotor motor or even through a variable-speed coupling.

Such means of control is obviously unaffected by the relationship between the temperature and the pressure at the suction of any one of the pumps and conditions might arise where the speed regulation lowers the suction pressure of any given pump dangerously close to or even below the required minimum. In such installations, therefore, it is absolutely necessary to provide some form of lower limit control to the speed of the pump which is subject to variation, this lower limit being determined on the basis of the rule indicated.

Referring specifically to Fig. 10, it will be seen that the system illustrated consists of a constant-speed condensate pump, followed by a closed heater, a variable-speed primary feed pump, another closed heater and finally a constant-speed secondary feed pump. While at full load the temperature of the feedwater leaving the individual pumps is, for practical purposes, equivalent to the temperature at the pump suction, this does not hold true at light loads and, for that reason, the illustration indicates this by using different subscripts for the temperatures at the suction and discharge of each pump. It is obvious that the margin between the pressure at the suction of the secondary feed pump (P_4) and the vapor pressure corresponding to the temperature T_4 must never be allowed to fall below a certain predetermined value, which depends on the pump design.

Selection of the individual pump discharge pressures is a relatively complex problem, which is affected by the amount of required pressure regulation—that is by the system-head curve of the boiler feed cycle—by the head capacity characteristics of the individual pumps, the maximum temperatures of the feedwater at the outlet of the various heaters, the permissible speed variation of the variable-speed drives and, finally, by the desired maximum hydraulic pressure to be imposed upon the intermediate closed heaters. Fig. 11 illustrates qualitatively the characteristics of a typical closed system such as in Fig. 10. For purposes of simplification, frictional losses between the pumps have been neglected.

It will be seen that the pressure at the discharge of the secondary pump considerably exceeds the required system head pressure at light loads if all the pumps are operated at constant speed and that, even if the primary feed pump is by-passed altogether, the secondary feed pump can develop sufficient pressure from shut-off to capacity "A".

In other words, the speed variation required of the driver of the primary pump ranges all the way from 0 to 100 per cent. This obviously is impractical for a great many reasons, especially if the pump is driven by a wound rotor motor where reduction of speed below 50 per cent of design speed is seldom practiced. As a result, the operation of such a cycle at variable speed generally takes place along the lines illustrated in Fig. 12. Whatever excess pressure remains is throttled by the feedwater regulator.

The important feature of a proper selection of primary feed pump conditions and of suitable variable-speed control is that means must be made available to prevent the discharge pressure of the primary feed pump (P_3 in Fig. 10) from falling below a certain minimum determined by the relationship between P_4 (P_3 less losses through the closed heater) and the vapor pressure corresponding to the temperature T_4. If certain operating conditions arise that might lead to a dangerous reduction of the difference between P_4 and the vapor pressure at T_4, some control must be instituted, actuated by this difference and arranged to set a definite limit to the speed reduction called for by the excess pressure regulator. Figure 12 indicates the introduction of such a speed-reduction limiting control, whereby the discharge pressure of the primary feed pump is not permitted to fall below a predetermined minimum.

For the sake of simplification, it has been assumed that the value of T_4 is constant at all loads and, therefore, that the minimum permissible value of P_3 is likewise constant. Actually, the closed heaters are fed with steam bled from some given stage of the main turbine and the pressure and temperature of this steam are reduced as the load is reduced. Thus, in an actual installation, the process of checking the minimum permissible primary feed pump discharge pressures may be a little more tedious than indicated here.

Determining Discharge Pressure

Of the conditions of service to be established, the next in order is the

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advance in boiler feed water treatment!

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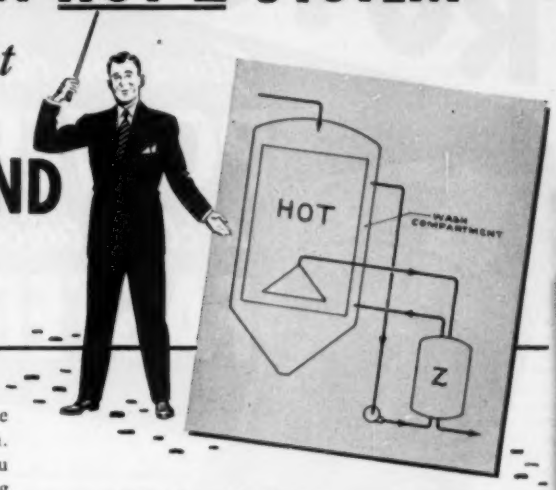
HOT PROCESS AND ZEOLITE



Choosing between Hot Process and Zeolite is no longer a boiler feed water problem. The Worthington Hot-Z System gives you the advantages of each system including deaeration.

SEE WHAT HOT-Z DOES FOR YOU:

1. Reduces hardness to 0.2 ppm without addition of excess soda alkalinity.
2. Operates on cheapest chemicals — lime and salt.
3. Saves enough in chemical costs to pay for average installation in 3 years.
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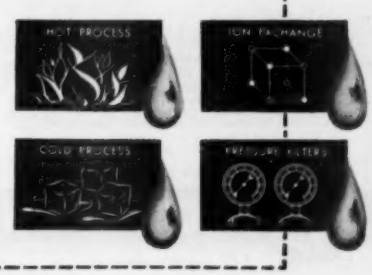
INVESTIGATE! If you are now considering split treatment, hold up your decision until you examine the Worthington Hot-Z System. Tell us your conditions of service and get our recommendation in terms of dollars and benefits. You'll find in our Hot-Z System, as in so much other equipment, *there's more worth in Worthington. Worthington Pump and Machinery Corporation, Water Treating Division, Dunellen, N. J.*

30-4

WORTHINGTON

WATER CONDITIONING

Worthington Makes More of the Equipment for All Types of Water Conditioning Systems



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You won't believe any tube cleaner can pack such tremendous power, until you try the new ROTOJET. It removes scale so much faster that it usually pays for itself in one cleaning. Models available for practically any size straight and curved tubes. Send for ROTOJET Bulletin.

THE SECRET

ROTOJET Motor has only two moving parts, a shaft and a paddle. Positive contact between paddle and Rotocentric (egg-shape) bore cylinder prevents stalling at low speeds. No leakage. Delivers maximum power for air used.

S-530 ROTOJET Air-driven Motor with swing-frame head for 3¼-3-13/16" I.D. straight tubes.

ELLIOTT COMPANY-ROTO DIVISION

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discharge pressure against which our boiler feed pumps will operate. Only too frequently a specification gives the boiler pressure rather than the desired discharge pressure, leaving the manufacturer's engineers to guess at the losses in the piping, static elevation differences, pressure drop through the feedwater regulator and desired or expected margin of safety. It is true that past statistical experience has shown that the boiler feed pump discharge pressure will vary from 115 to 120 per cent of the boiler pressure. But these figures represent only an average and power plant operators know quite well that there is no such thing as an average power plant.

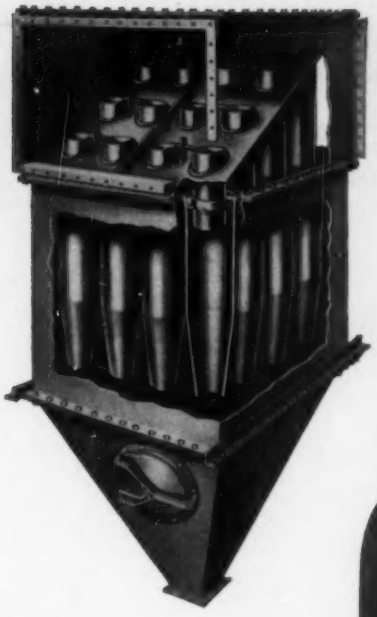
To determine the discharge pressure for which the boiler feed pumps are to be designed, it is necessary to obtain the sum of the maximum boiler pressure and of all the frictional and control losses which occur between the boiler feed pump discharge nozzle and the boiler inlet. The calculations of the frictional losses must, of course, be based upon the maximum capacity previously determined. Figure 13 illustrates the various factors which must be considered in establishing the discharge of a boiler feed pump.

The following represents a typical calculation of the required discharge pressure for a boiler feed pump designed for 500,000 lbs per hour and required to feed a 850-psi boiler. (Numbers in parentheses refer to Fig. 13).

Maximum drum pressure (9) based on all safety valves blowing	930 psig
Economizer pressure drop (8) at maximum capacity	58 psi
Static head converted into psi at average pumping temperature	24 psi
Feedwater regulator pressure drop (7) at maximum capacity	40 psi
Pressure drop through flowmeter (6) at maximum capacity	3 psi
Friction losses through piping and valves (5) at maximum capacity	42 psi
Friction loss through stage heater (4) at maximum capacity	38 psi
Excess pressure regulator pressure drop (3) at maximum capacity	25 psi
Total	1160 psig
Safety factor	40 psi
Design Discharge Pressure	1200 psig

System Head Curves

At constant speed, the capacity of a centrifugal pump varies with the head which it generates, the pump capacity increasing as the head decreases while the actual shape of the head capacity curve is a function of the type of the pump, in other words of the pump specific speed. At the same time, when a pump has to overcome frictional losses in addition to a pressure or a static head, as is the case with boiler feed pumps, the head against which the pump has to work varies with the capacity delivered. The curve representing the relation between the capacity and the head against which a centrifugal pump must work is called the system head curve and represents the locus of all the points obtained in the same manner as the



In dust and fly ash recovery

MULTICLONE COLLECTORS

and only Multiclones give vital advantages like these...

No wonder "MULTICLONE" is the leading name in the centrifugal recovery of dust and fly ash from all types of gases, hot or cold.

No other mechanical recovery equipment has so many years of dust and fly ash recovery experience behind it... or has such uniformly high collecting efficiency... or provides so many other money-saving, space-saving advantages as MULTICLONE. The four advantages outlined below are by no means the complete MULTICLONE story, but are typical of the vital savings found *exclusively* in MULTICLONE equipment...

Uniformly High Recovery:
MULTICLONE'S multiple *small diameter* tubes—made possible by its exclusive vane design—whirl the dirty gases with greater centrifugal force, thus throwing out not only the large, medium and small particles, but also a high percentage of the *extremely small* particles of 10 microns and less. This, coupled with the fact that there are no pads or filters to become choked with recovered material, results in a more complete recovery of *all* suspended materials from the gas stream.

Long and narrow

Square

Maximum Adaptability:
In addition to its unusual compactness, the MULTICLONE is also unusually adaptable to various installation requirements. Where head room is low it can be installed with side-inlet side-outlet connections. Where side clearances are restricted, it can be installed with side-inlet top-outlet connections. In addition, without changing capacities, the shape of the unit can be varied—long and narrow, short and wide, or square—to fit restricted spaces ...and its single-inlet single-outlet duct requirements permit greater flexibility and simpler installation. These savings slice installation costs, space requirements and insulating expense.

Space-Saving Compactness:
Plant space costs money—so be sure to check space requirements carefully. As shown in the accompanying chart, the MULTICLONE requires less floor space and less cubic space than any other unit of comparable capacity and performance. Translate these savings into today's high costs for plant space and you readily see the great importance of this one MULTICLONE advantage alone!

Make	Relative Space Requirements In Sq. Ft.	In Cu. Ft.
Multiclone	1.0	1.0
Collector A	2.1	1.0
Collector B	5.9	3.2
Collector C	6.8	3.9

Minimum Maintenance:
The MULTICLONE has no high speed moving parts to repair or replace... no pads or filters to clean or renew... nothing to choke the gas flow or increase draft losses as suspended materials are recovered. MULTICLONE draft losses remain uniformly low *at all times*. Further, the recovered material from an entire bank of tubes is collected in a *single* hopper—far easier to service and maintain than the multiple hoppers of conventional cyclone units.

FREE INFORMATIVE BOOKLET
This 32 page booklet outlines the basic principles of centrifugal dust recovery and shows the *many* ways MULTICLONE advantages assure higher recovery at lower overall costs. A free copy of this booklet will gladly be sent on request. Write today!

Before you decide on any recovery equipment be sure to get complete information on MULTICLONE advantages. A letter, wire or phone call to our nearest office places this information in your hands without obligation. Get *all* the facts and you will get MULTICLONE Collectors!

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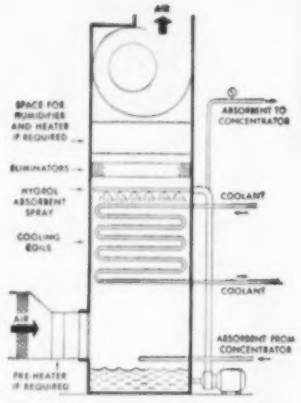
How You Save with the NEW Niagara Method of Air Conditioning

Using "Hygrol" Hygienic Absorbent Liquid

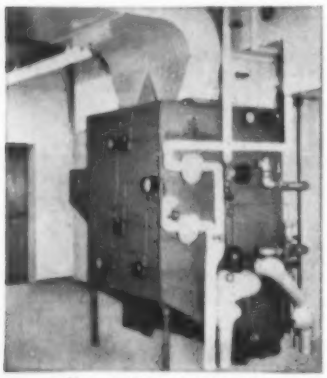
Because it absorbs moisture from the air directly, the new Niagara Controlled Humidity Method uses less, or no, mechanical refrigeration for dehumidifying. You save first costs and installing of heavy machinery. You save space, maintenance expense, power. You get easier, more convenient operation.

Using "Hygrol" hygienic absorbent liquid, this method gives complete control of temperature and relative humidity. Especially, it is a better way to obtain dry air for drying processes, packaging hygroscopic materials, preventing moisture damage to metals, and obtaining better quality for chemical process products and food products—or in obtaining better results in comfort air conditioning for office or laboratory at lower refrigeration costs.



NIAGARA CONTROLLED HUMIDITY METHOD — FLOW DIAGRAM

Food Packaging under Controlled Humidity


Niagara Controlled Humidity Air Conditioner

The diagram shows how filtered air is dehumidified by passing thru a spray of "Hygrol"—a liquid absorbent which removes air-borne moisture. This liquid is hygienic and non-corrosive; it contains no salts or solids to precipitate and cause maintenance troubles. It is continuously re-concentrated at the same rate at which it absorbs moisture, providing always the full capacity of the air conditioner, automatically.

Units provide a range of capacities from 1000 to 20,000 C. F. M. Multiple unit installations are in use successfully. Records of results are available. For further information, write Niagara Blower Co., Dept. E, 405 Lexington Ave., New York 17, N. Y.

maximum discharge pressure was previously established, except for varying capacities.

Such a system head curve is represented in Fig. 14 which, in addition, shows the total head generated by a boiler feed pump operating at constant speed. With no external means used to control the boiler feed pump capacity, the boiler feed pump will operate at the intersection of the pump head-capacity curve and of the system head curve. Since this operating point would correspond to the maximum boiler requirements and since the power plant load varies between zero and this maximum requirement, a form of control such as the feedwater regulator is used to make the pump operating capacity correspond to the specific boiler demand at all times. The function of the feedwater regulator is to alter the shape of the system head curve through the introduction of artificial friction so as to vary the operating point as required.

Figure 15 represents the operation of a centrifugal boiler feed pump at constant speed and illustrates the effect of the feedwater regulator throttling valve at several different positions corresponding to various flow requirements of the boiler. It has been assumed in this case that the boiler pressure is constant at all loads. Thus, depending on the boiler load and consequently on the position of the feedwater regulator throttle valve, the pump discharge capacity will correspond to the intersection of the head-capacity curve with curves (A) to (D) or with any intermediate curve.

Total Head

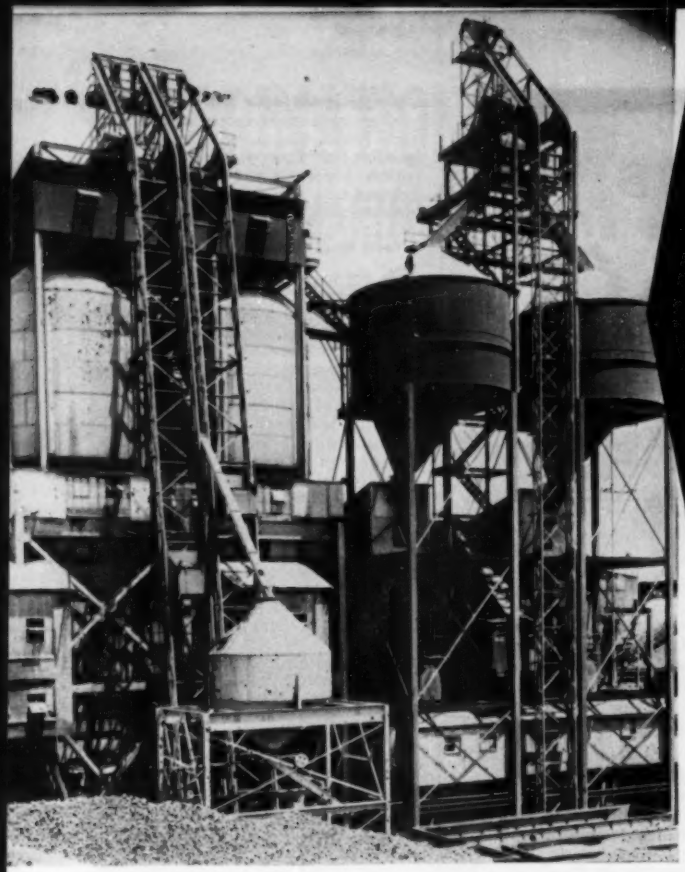
By definition, the net pressure which must be generated by a centrifugal pump is the difference between the required discharge pressure and the available suction pressure—both these pressures being referred to a common datumline such as the atmospheric pressure. Thus,

Net pressure (in psi)
= Discharge pressure (psig)
— Total suction pressure (psig).

At the same time, it must be considered that a centrifugal pump with a given impeller diameter and operating at a given rotational speed, generates a total head expressed in feet of the liquid pumped entirely independent of the specific gravity of the liquid. Therefore, prior to the selection of the impeller diameter, the pump designer must convert the required net pressure into a total head expressed in feet of water, using the following formula:

$$\text{Total Head in Feet} = \frac{\text{Net pressure in psi} \times 2.31}{\text{Specific Gravity}}$$

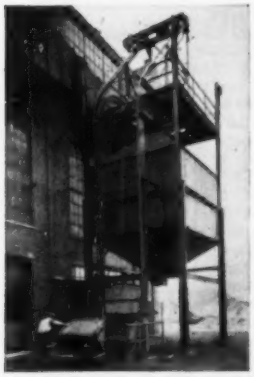
It is not necessary, in writing boiler feed pump specifications, to state the required total head as long as the discharge pressure and the prevailing suction conditions are given. As a matter of fact, it is



Low Cost Handling of Fuel and Ashes with LINK-BELT Skip Hoists

In the manufacture of 31 million cubic feet of water gas daily, the Elizabethtown Consolidated Gas Company handles carloads of coal and coke to provide red hot fuel and an ample supply of steam to the gas generators. To unload and store this fuel, and to dispose of boiler-plant ashes, three Link-Belt automatic skip hoists and one Link-Belt semi-automatic skip hoist have been found highly satisfactory. Skip hoists are well adapted in general to high lifts, and for handling large or coarsely broken, abrasive or corrosive material. Link-Belt automatic skip hoists are started by a push button, and bucket continues to load, elevate, and discharge until the track hopper is empty or the stop button is pushed. Automatic action, low power consumption, low upkeep and long life combine to make Link-Belt skip hoists a preferred means of handling coal, coke and ashes at such installations. Link-Belt engineers can give valuable aid in selecting the best type and size of materials handling equipment to meet your specific needs.

Above: Skip hoist on left is balanced bucket type, 147 ft. lift, with two 80 cu. ft. buckets. Link-Belt vibrating screens over two bins separate fines, or coke breeze, which is chuted to breeze bin, foreground, then loaded into cars and taken to boiler house. Single bucket, counterweighted type, on right has 155 ft. travel, 120 cu. ft. bucket. Fuel handling skip hoist at boiler house is single bucket, automatic type, with 128 ft. travel and 65 cu. ft. bucket.



Left: Link-Belt semi-automatic skip hoist, 45 ft. travel with 30 cu. ft. bucket for placing boiler house ashes in bin for loading into trucks.

Right: 80 cu. ft. skip bucket at top of lift, immediately after discharge.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Johannesburg. Offices in Principal Cities.

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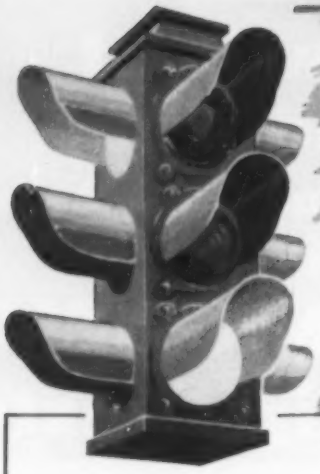
LINK-BELT

COAL AND ASHES HANDLING MACHINERY



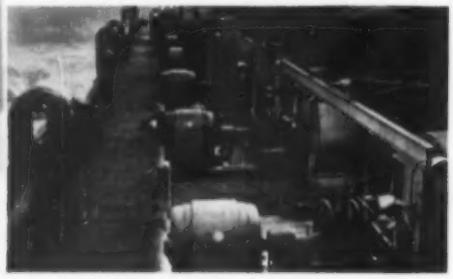
DRAFT FANS GO on GREEN

A Big Draft Job Handled Capably by Green Fans

Twenty-four large Green Fans take care of a heavy draft load at the Venice (Illinois) Plant of the Union Electric Co. of Missouri. Each of six boilers has two sets of Green Fans, each set consisting of one induced draft fan and one forced draft fan coupled to one motor as a unit. With the heavy demands on this station, all boilers are usually in service continuously, thus throwing an unrelenting burden on the fans.

Engineers whose responsibility it is to recommend or accept draft fans for large power plants certainly want efficiency and low operating costs. But they don't overlook the maintenance and replacement angles. They want the sound designs of competent experienced fan engineers. They also want the care in construction that is found in shops of a company that has built up an international reputation as the "authority" on draft fans. They know that such a company will not tolerate sloppy shop work.

Green is this authority on mechanical draft fans.



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THE GREEN Fuel Economizer COMPANY INC.

BEACON 3, NEW YORK

ECONOMIZERS • FANS • AIR HEATERS • CINDERTRAPS

safer to specify the latter two only, rather than suction pressures and total heads. The reason for this suggestion is that the specification writer generally works in terms of psi and will give more accurate conditions with less effort involved.

Total Head at Varying Temperatures

In the majority of cases, the pressure in the direct-contact heater at the boiler feed pump suction is either pegged at a constant value or varies with the load in a predetermined manner. There are certain installations, however, where the pressure at the suction, and therefore the temperature, may vary independently of the load. It is important, in such cases, to establish the proper method for determining the total head of the boiler feed pump.

Let it be assumed, for the sake of illustration, that a given installation requires a discharge pressure of 500 psi, that the net positive suction head is 20 ft and that the pressure in the direct contact heater varies from 5.3 psig to 29.3 psig. The temperatures corresponding to these two pressures are 228F and 273F, respectively. The problem is to determine which of the two extreme conditions should be used to establish the required head—in other words, which of the two give the highest total head.

At 228 F specific gravity = 0.953

At 228 F total suction pressure = $5.3 + \frac{20 \times 0.953}{2.31} = 13.5$ psig

At 228 F net pressure = $500 - 13.5 = 486.5$ psi

At 228 F total head = $\frac{486.5 \times 2.31}{0.953} = 1175$ ft

At 273 F specific gravity = 0.933

At 273 F total suction pressure = $29.3 + \frac{20 \times 0.933}{2.31} = 37.4$ psig

At 273 F net pressure = $500 - 37.4 = 462.6$ psi

At 273 F total head = $\frac{462.6 \times 2.31}{0.933} = 1145$ ft

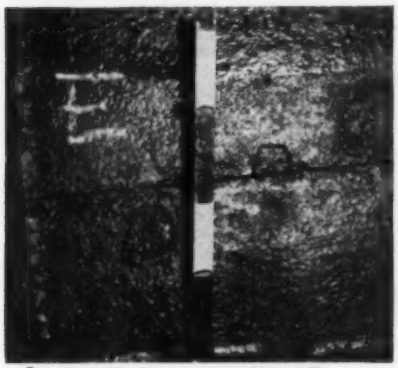
In this particular case, it will be seen that the maximum total head requirement corresponds to the minimum temperature condition and the pump must be designed for 1175 ft. This is because the increase in head caused by a lower specific gravity at 273F is more than compensated by the decrease in net pressure due to the higher vapor pressure at the suction. This will not always be true, as with increasing net pressures, the increase in suction pressures becomes a constantly smaller percentage of the pressures involved. It follows that the best procedure on the part of the writer of a boiler feed pump specificaton still remains to state the required discharge pressure and the possible variations in suction conditions and temperatures.

CHLORINATION BY WALLACE & TIERNAN

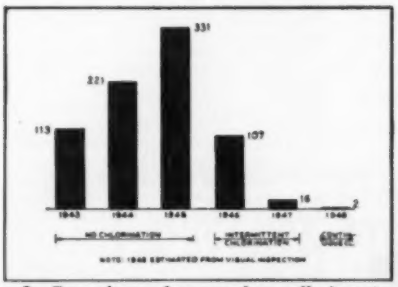
CONTROLS MARINE FOULING AT GENERATING STATION

LOOK AT THESE RESULTS

1. Before chlorination — mussels cover wall to depth of 3".



2. After chlorination — note bare wall.



3. Tons of mussels removed annually from intake tunnel of generating station.

It all began when a New England generating station sent down a diver for a routine inspection of the large, concrete, circulating-water, intake tunnel located approximately 13 feet below the harbor's surface. The diver discovered this intake was lined with unusually heavy growths of common mussel (Mytilus), sea moss (Tubularia), and sea anemone (Metridia).

These were expensive visitors. First, mussel accumulation created poor vacuum as the mussels lodged in condenser tubes and aggravated slime and silt formation. Then, as the mass increased in quantity, it became necessary to clean the intake tunnel every year to remove up to a maximum of 331 tons of mussels — a time consuming process that cost thousands of dollars in labor and equipment outage.

To combat these conditions a long and thorough study was made of marine fouling. As a result it was decided to use intermittent chlorination applied by Wallace & Tiernan Chlorinators. First to fall under this attack were the sea moss and the sea anemone. The tougher mussels however, still remained as numerous as ever.

In an all out effort to get rid of these trouble makers, continuous chlorination at heavier residuals was started. This treatment turned the trick and the mussels were reduced to such a low level that yearly cleaning has not been required.

These results saved the New England company thousands of dollars annually by eliminating intake tunnel cleaning, reducing condenser outages, and producing a higher vacuum with a resultant saving in fuel.

Perhaps your problem is one of slime or fouling due to some other marine organism. In any event, if biological fouling is costing you money through lowered cooling water efficiency it's a safe bet that chlorination can help.

See your nearest Wallace & Tiernan Representative now for all the details.

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DART UNIONS

TECHNOLOGICAL AND ECONOMIC CHANGES

(Continued from page 75)

tive systems. To the average management of a small company, as well as to some large ones, the power plant is a necessary evil. The owners would rather spend money on production machinery where dollars and cents spent reflect more visibly the cost of their product. For this reason they generally chose the incentive plan.

I must confess that I was very unhappy at first when management insisted that I save the investment cost and use the incentive plan. For like any young engineer I dreamed of what a good job I could do with improved equipment. But when I saw the results I obtained with the incentive system I realized that perfection does not depend entirely on equipment. I expected a lower efficiency due to the lower heat value of cheap coal but to my amazement some of the firemen were so interested in making extra money that they watched the fires and the efficiency so much more attentively that not only did the management benefit from the difference in fuel cost but also from the lower fuel consumption[4] resulting from higher efficiency.

Scheduling—1932 Depression Engineering

After 1930 when the business depression was gnawing at the country's economy the average manufacturer was struggling with the question of whether to get out of business or to hold out and operate at below "break even" point. Almost all manufacturers were confronted with the problem of how to operate their plants at less than capacity and yet run them efficiently and at low cost. Manufacturers were in no mood to spend money for increased efficiency even if they were not head over heels in debt. Cash was the most expensive item then.

Under such conditions I had to use every device at my disposal to effect savings without investment on new equipment. Even this was not enough, for the average concern would not even spend money on maintenance and repair unless there was a serious breakdown.

The limitation of my services to no investment, no repair and maintenance, was not all. I had to include in most cases no increase in efficiency. There is a limit to what one can do with equipment that operates at low efficiency at low load and that cannot be replaced with equipment of smaller size or different design. But when one does not give up he always finds something—and in my case what I found was scheduling—the depression cure

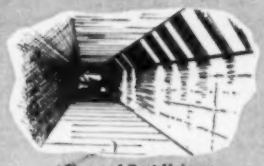
[4] Additional studies made in incentive plans in boiler and power plants were published in *Industrial Power* in 1930 entitled "Incentive Plans & Engineering Factors."

WHERE TO USE LUMNITE IN POWER PLANTS

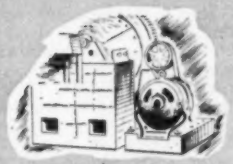
Steel Stack Linings

Ash Pit and Cinder Catcher Linings

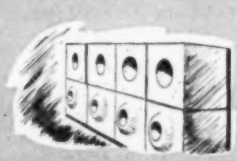
Coal Bunker Linings



Flue and Duct Linings



Overnight Structural Concrete

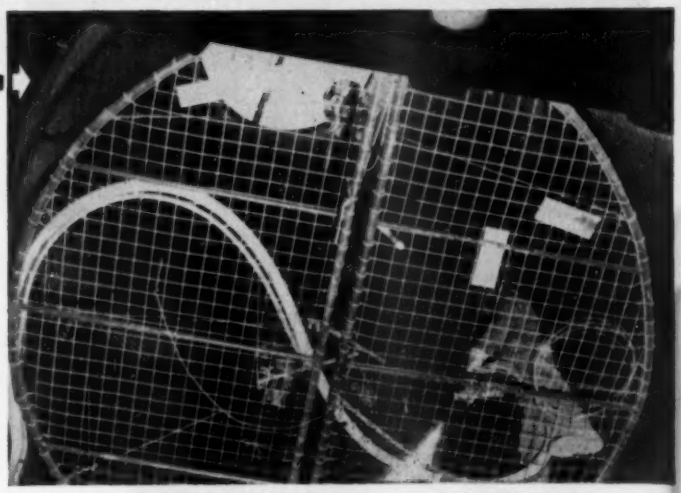


Castable Refractories

Factory-prepared mixtures of LUMNITE and selected aggregates. Mixed with water on the job, cast into place for door linings, arches, baffles, furnace walls. Special shapes can be cast in molds, ready within 24 hours. Castables to meet different temperature and insulation needs are made by manufacturers of Refractories, sold by their distributors.

Lining steel stacks with LUMNITE*

STOPS CORROSION IMPROVES DRAFTS



Looking up through working platform in stack being lined with Lumnite refractory concrete. 2½" lining is being "shot" by concrete gun over reinforcing mesh attached to angle plates welded to steel shell.

CORROSION, the No. 1 enemy of steel stacks, won't harm this one. It's getting a protective lining of refractory concrete made with Lumnite calcium-aluminate cement. The Lumnite concrete will resist corrosive attacks of condensate and sulphurous gases. In the breechings, it will withstand the abrasive action of high-velocity gases and fly ash.

Drafts will be boosted, too. Lumnite cement, mixed with insulating aggregates, keeps gas temperatures high, cuts condensation inside the stack. And because the lining is smooth and jointless, there will be less loss of draft.

Easily Installed – Maintenance Reduced

Lumnite linings may be troweled into place or "shot" on by concrete gun as shown above. Because Lumnite linings are jointless, there are no small units to work loose. Thus less maintenance is required. When repairs are necessary, they can be made quickly and cheaply, for Lumnite reaches full service strength in 24 hours or less.

Depending on requirements, Lumnite provides high structural strength, high heat resistance and low thermal conductivity. Write for descriptive booklet on Lumnite for stacks, and other refractory, insulating, corrosion and heat-resistant concrete installations in power plants.

"LUMNITE" is the registered trade mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.

PE-L-32

Lumnite Division

UNIVERSAL ATLAS CEMENT COMPANY

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that pulled my consulting services out of the slump. Scheduling of production was devised to split up the work in such a manner that it reduced either the fuel cost or power cost, whichever offered the greatest reduction.

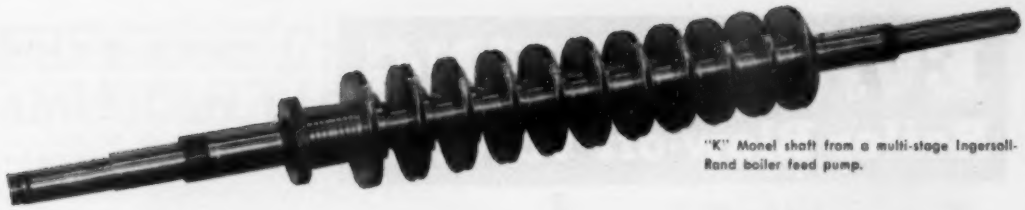
As an example, in the case of the Foundry described in detail in *Power Plant Engineering* in May, 1935, I found that the electric energy consumption dropped practically in proportion to the drop in production while the demand charge dropped only 8 per cent when the monthly tonnage dropped from 780 to 200 tons of steel per month or about 75 per cent. The reason the electric demand cost did not drop was because my client was adhering to the same schedule of operation as that in boom days of 1929. By spreading his operations in a mannner that did not increase his labor cost it was possible to reduce this demand as seen in chart (Fig. 5) and a saving of $4920.00 per year was affected.

In another case where considerable steam for process was used benefits were obtained by shortening the time of operation. In this way the boiler load was increased, thus increasing the efficiency of combustion, and at the same time the steam losses, such as radiation, leaks, flash, etc., were reduced because the plant operated shorter hours.

John L. Lewis Boiler

At the beginning of and during World War II government regulations limited the use of fuel oil and forced consumers who could adapt their plants to burning coal to convert from oil fuel to coal. Thus the transition from a coal to an oil era which had been under way for a number of years, as pointed out later, was reversed and it gave John L. Lewis the chance of a life time to obtain increased wages for his miners through strikes. This continued for several years even after the war when fuel oil was still scarce and when the industry was more concerned with converting to peace time production than to burning oil.

Beginning about 1948, however, there was an exodus from coal. The coal consumer objected to paying higher prices for coal and objected above all to the closing down of the factories during the prolonged strikes. With the price of coal rising, coal considered the less dependable fuel and a general bitterness against prolonged strikes, the industry turned to fuel oil and to the limited amount of available gas fuel, on a scale never experienced in the Chicago area. Oil and gas burner suppliers and also oil and gas fuel suppliers reduced their sales organizations, regarding John L. Lewis as the best oil and gas salesman the country ever had. Many coal burner manufacturers jumped aboard the



"K" Monel shaft from a multi-stage Ingersoll-Rand boiler feed pump.

"K" MONEL FOR PUMP SHAFTS...

Corrosion-resistant? *Yes!*

Heat-treatable *after* machining? *Yes!*

Strength and hardness close to alloy steel? *Yes!*

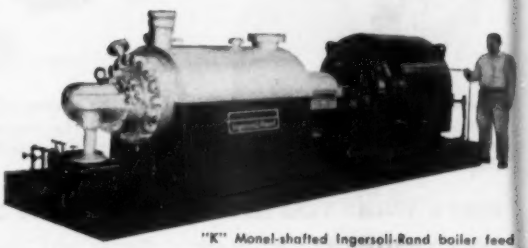
"K" Monel . . . an alloy that may be heat-treated to attain maximum properties . . . has several important qualities that recommend it particularly for pump shafts.

In many pump designs, the shaft must be long and thin, yet capable of withstanding extreme loading as well as highly corrosive conditions. This combination of design factors demands a shaft metal that possesses high strength and hardness, unusually high resistance to corrosion, and high resistance to corrosion-fatigue.

"K"® Monel meets these requirements successfully, and in addition offers the advantage that it may be heat treated for high strength and hardness *after* machining without undue distortion.

Typical installations of "K" Monel-shafted pumps are those of the American Gas and Electric Company System. At three central stations, located in West Virginia and Indiana, a number of Ingersoll-Rand multi-stage pumps are used for boiler feedwater injection.

These pumps operate against a boiler pressure of 2000 psi and higher, and handle water at an average temperature of 304° F. Each pump delivers 1100 gallons per minute at a total dynamic head of 6000 feet.



"K" Monel-shafted Ingersoll-Rand boiler feed pump of the type used by the American Gas and Electric Company System. Manufactured by *Ingersoll-Rand* Company, Phillipsburg, N. J.

These severe conditions demand a shaft metal that is strong, wear-resistant, and corrosion-resistant. Heat-treated "K" Monel has proved entirely satisfactory in this service.

If you are concerned with pump purchase or maintenance, you will be interested in "*How to get longer life from your pumps.*" Write to R. F. Johnson of INCO for your free copy.

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The unique service qualities of EVERLASTING Blow-off Valves have long been demonstrated in boiler-rooms throughout the country. Now their superior design features have been teamed up in these new EVERLASTING Duplex Blow-off Units.

HERE'S WHAT YOU GET WITH THESE NEW DUPLEX UNITS

Sealing Valve (shown on left of unit)

- Lever- or wheel-operated types—as you desire
- Unrestricted flow — straight-through
- Rotating sliding disc—self-grinding, self-lapping
- Drop-tight seal—improving with use
- Non-wedge action — no sticking, no jamming

Blowing Valve (shown on right of unit)

- Straight-way or angle types to select from
- Strength to withstand repeated shock of blow-off force
- Exceptional resistance to erosion, abrasion and rust
- No pockets to permit lodgment of solids
- Positive action, self-cleaning

Not only do these EVERLASTING Duplex Blow-off Units provide an absolutely drop-tight seal — they are so constructed that long and repeated operation will not affect this tightness. Other Duplex Units for varied requirements are shown in our Bulletin.

Either valve of any EVERLASTING Duplex Unit can be supplied separately. But for boiler blow-off applications, any one of the complete EVERLASTING Duplex Units assures absolute safety — at low maintenance cost.

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oil burner equipment band wagon.

As previously mentioned, my first experience in the United States was to interpret engineering service in dollars and cents investment return. Now, however, I entered a period where this rule did not hold true. Many of my larger clients who had considerable investment in efficient coal burning boiler installations and could burn coal at the same and even slightly lower cost than fuel oil decided to convert their installations to use a combination of fuel oil and dump gas fuel. In other words these boilers discontinued burning coal ahead of the normal engineering and economic trend and therefore were referred to as the John Lewis type boilers. Most boilers, however, were redesigned to burn 3 fuels, i.e. coal, oil and gas.

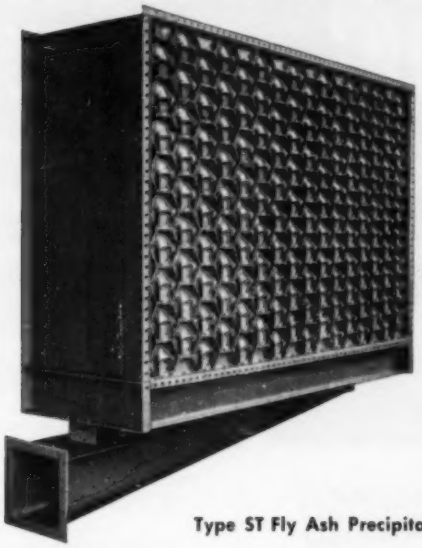
Oil Leaves Coal Behind

The influence of the coal strikes upon the general trend in the use of fuel was not basic. The trend from coal to oil was already in progress and John Lewis with his coal strikes only accelerated the transition process. As I pointed out earlier in this article, when I came to Chicago in 1924 coal was the predominant fuel but in the 25 years since that time, many changes have taken place to change the importance of coal. The establishment of immense oil refineries near Chicago, the intensive development of fuel oil resources in the United States, the discovery of oil fields in Illinois and other parts of the country, the increased world output of oil, were factors that contributed directly to the transition from coal to oil. Other secondary factors, such as changes in methods of transportation—the increased use of trucks and pipe lines, improvements in methods of handling heavy fuel oils at the plant and the changes in design of oil burners also were of importance.

To an engineer such as the writer who partook of the development of the improved oil burner and who had to overcome difficulties of burning oil efficiently and at low cost, the burner was the most important single factor in the progress of oil burning.

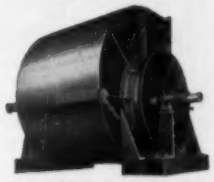
Twenty-five years ago the oil burner used steam as a source of power to break up and atomize the oil to a state fine enough so it could burn satisfactorily. Even though this so-called steam atomizing burner was then the best performer it was very inefficient and costly to operate. Its design was poor and it was constructed of soft metals. The hard wearing metals, stainless steel and Monel, were not generally known or used in industry. Besides, the steam itself was costly because the boilers supplying the steam to these burners operated at very low efficiencies. It is interesting now to

Solve your *fly ash problem* with an AMERICAN BLOWER FLY ASH PRECIPITATOR

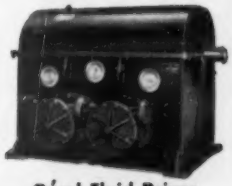


Type ST Fly Ash Precipitator

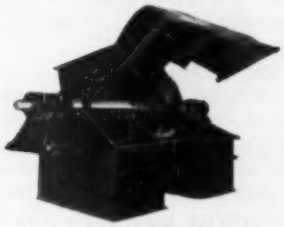
Heavy Duty Coils



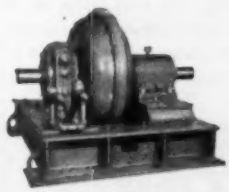
American HS Forced Draft Fans



Gýrol Fluid Drives for Boiler Feed Pumps



Sirocco Induced Draft Fans



Gýrol Fluid Drives for Mechanical Draft Fans

There are many advantages in using American Blower Type ST Precipitators for fly ash problems. Unique in design, simple in operation and low in maintenance cost, these units contribute materially to over-all power plant efficiency.

They automatically maintain high efficiency over the entire boiler load. Even at reduced loads, when fly ash is more difficult to remove, the Type ST Precipitator is relatively more efficient.

In addition, all element cells are die-formed, interchangeable and housed in a single, compact casing. Type ST units are flexibly designed to fit the job. They may be shipped for field assembly, or semi-assembled. They're available in a wide range of sizes to meet a variety of needs.

If you have a fly ash problem, why not call in an American Blower Field Engineer and work your needs out together? He has a wealth of experience behind him and excellent firsthand data at his disposal on Fly Ash Precipitators as well as on American Blower Heavy Duty Coils, Mechanical Draft Fans and Gýrol Fluid Drives for fan control and boiler feed pumps. Simply contact the nearest American Blower Branch Office—conveniently located in all principal cities.

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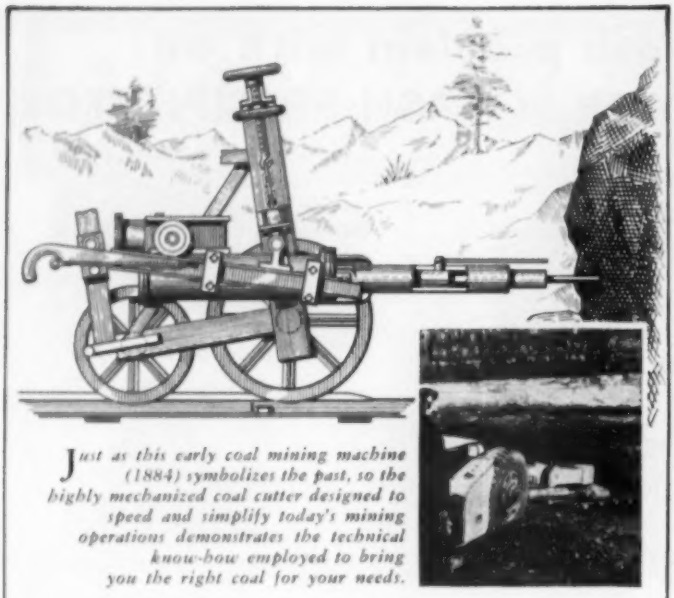

Just as this early coal mining machine (1884) symbolizes the past, so the highly mechanized coal cutter designed to speed and simplify today's mining operations demonstrates the technical know-how employed to bring you the right coal for your needs.

SOUTHERN'S Coal Engineering

the modern approach to scientific application

Right coal selection and application to specific types of burning equipment—that's the specialized mission of Southern's coal engineers! Yes...our engineering service has kept apace of modern mining techniques. This service is of vital importance to buyers of industrial coal.

Here is Southern's modern approach to boiler-room problems: Scientific plant surveys—recommendation and selection of the most logical coal—carefully conducted actual burning tests. More often than not, the results of our surveys and tests mean big savings in coal purchases, plus maximum efficiency. One of our engineers will be glad to work with you—without obligation.

SERVICE FROM AMERICA'S LEADING COAL FIELDS—Southern offers industrial buyers a wide variety of premium coals from the coal fields of Western Kentucky, West Virginia, Virginia, Eastern Kentucky, Illinois, Alabama, Arkansas and Oklahoma. *One is right for your plant!* Write, wire or telephone the nearest Southern office for complete information.

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MEMBER

know that in those days about 20 per cent of the fuel oil purchased was used for the sole purpose of making the oil burn compared to approximately 3 per cent in the case of present day steam atomizing burners.[5]

Obviously, a burner that could use electricity or mechanical power for atomization was badly needed. For me, the prophecy made 25 yr ago by F. B. Orr, Assistant Vice-president of a Chicago public utility, is unforgetable. Mr. Orr engaged my consulting service to test and analyze the performance of a Vulcan rotary cup burner, one of the very first burners introduced in Chicago by Harry Shaffer and Henry Naft. "A rotary cup burner of some sort will be the popular industrial burner of tomorrow," predicted Mr. Orr. This prophecy was made despite the disappointing results of my tests and reports: that it was difficult to maintain a stable flame and that the burner adjustment was as uncertain as the flip of a coin. Yet his prophecy became a reality. In 1926 or 1927, the two companies came out with an improved rotary cup burner having features of design used to date, and these burners are still identified with the best rotary cup burners of 1950.

All Air Around the Rotary Burner

Progress can be said to flow by fits and starts. At first much progress is made through intensive work on improvements. Then comes a period of satisfaction with the progress, when little or no improvements are made; in other words, a period of stagnation follows. The resumed progress on burners had a special significance for me. During the past 20 yr I made studies on the value of admitting "all the air" around the burner. The rotary burner manufactured in the early days of burner development used only 10 per cent to 20 per cent of the total air admitted at the burner and the balance below the burner at the furnace floor. I traveled the country over, meeting the manufacturers of the rotary cup burners and discussed with them my studies and findings.

Now, in 1950, when the application of this principle to rotary cup burners has increased tremendously, it is of interest to mention that some of the manufacturers told me that "all air around the burner" is only beneficial and practical with pressure and steam atomizing types of burners. Others told me that there will be no improvement in the performance of the rotary cup burners because it already uses some air at high pressure around the burner. Still others questioned my data and

[5] The oil burner in the average industrial plant in 1924 consumed about 8 per cent of the total steam. With the average boiler efficiency of about 50 per cent, it meant 16 per cent of the fuel oil. In addition 4 per cent of the fuel was required to heat it to a point where it was fluid enough to flow to the burner.

FORCED BOILER OUTAGES TURBINE SANDBLASTING, ELIMINATED!

BEFORE Allis-Chalmers Silica Removal Service	AFTER Allis-Chalmers Boiler Feedwater Service Installed
57 Boiler shutdowns in 33 months with 834 boiler hours of unscheduled outage.	Boilers and turbines operate 14 months between scheduled cleanings!
133 Tubes replaced. 29 Tubes welded.	*No* boiler tube failures!
Turbines sandblasted every 4 months.	*No* turbine sandblasting!
Power Production down 50% before each cleaning.	Rated power capacity is maintained!

ACTUAL CASE!

SILICA REDUCTION IN BOILER FEEDWATER with Allis-Chalmers chemicals and treatment produced these startling power plant economies at the Southern Advance Bag & Paper company, Hodge, Louisiana.

One of the leading manufacturers of paper bags in the south, this company has a daily steam production average of 9,350,000 lbs from 10 boilers serving 5 turbines generating 12,000 kw, a number of turbine-driven auxiliaries, and turbines operating paper machines.

Raw water analyses taken over a period of three years at Southern Advance show a silica reduction of 94% due to the use of Allis-Chalmers chemicals.

You can get similar results from A-C water conditioning service, chemicals and equipment.

Whatever your industry — paper, petroleum, food, steel — you'll get prompt, convincing results with Allis-Chalmers water conditioning service. An expert representative is available, ready to recommend proper chemicals or help select the right process for your power plant requirements.

Get in touch with him today at your Allis-Chalmers Office for complete information.

JOHN B. DAVIS, with 15 years experience in power plant water conditioning, is one of the A-C specialists located around the country to advise you of correct water conditioning equipment, chemicals and service.

ALLIS-CHALMERS

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whether "all air around the burner" is of benefit to any type of burners. There were some burner manufacturers who told me that the oil burner was a packaged machine, for sale at competitive price, and that they could not afford to spend money, re-adapting the burner.

I continued to visit manufacturers, as well as prominent combustion engineers, however; and my greatest encouragement came from George P. Haynes, Engineer of the Navy and formerly Chief Engineer of the Todd Combustion Equipment Co., a burner manufacturer. He advised me that my data and graphs were in accord with the results obtained by the Navy Experimental Station and suggested that I publish them.[6] Though early burner manufacturers, such as the Helios Mfg. Co., who started out with "all air around the rotary cup burner" went broke, and World War II made it necessary to abandon efforts in that direction, the progress of the burner these past five years, has been unimpeded. For the writer, who saw the problems of rotary cup burner manufacturers' representatives (The manufacturers of rotary cup burners were, till most recently, the greatest skeptics), plus his own problems to make such applications practical, the progress was painfully slow. It was, however, most gratifying when Henry Naft—Vice-president of the Enterprise Heat & Power Company—who engaged me in this work told me, with enthusiasm, after testing the first installation, that he had obtained results never before achieved at low load and with least adjustment; and to hear the Chief Engineer of the Todd Combustion Equipment Company, Chicago Office, tell me that with air all around the burner flat characteristic efficiency performance can be had; namely, efficiency does not drop as fast at low load as it does with the rotary cup burner not equipped with all air around the burners. This shows the progress made in one type of burner used for commercial and industrial steam plants. Other types of burners made faster progress, for instance the change from coal to oil or gas was at a faster rate in the industrial furnace application as this industry is almost entirely away from coal. All of which tends to show the effect of technological and economic changes on the industry, and that the engineer has to meet these changes and work with the trend.

[6] Published as a book in 1940: *Correcting Oil Burner Deficiencies*, still the only source of data on the effect of air around the burner at various pressures.

INSULATION METHODS

(Continued from page 61)

heads and lower halves of large horizontal tanks was held in place by tie-wires anchored to clips welded to the vessel surface. Removable heads on evaporators, tank heaters

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and similar equipment were individually insulated so that the heads can be removed without disturbing the adjacent insulation and so that the insulation on the heads can be removed and replaced.

Insulation on ducts, flues, hoppers and fan housings was protected by metal corner beading strips which not only prevent the tie wires from cutting into the insulation along the edges but also make an attractive looking installation. All outstanding legs or other projections on these types of equipment were insulated with molded material cut to fit the narrow surfaces. Insulation around bolted or hinged doors in fan housings or ducts was cut back so as to permit the full opening or removal of the doors, without disturbing or damaging the insulation.

Indoor pipe insulation was finished with pasted canvas jacketing, cut back to avoid contact with hot surfaces such as pipe bearings, etc. A strip of asbestos cloth was pasted on the insulation surface in the cut-away area.

An asphalt-saturated and coated asbestos felt jacket was the finish used for outdoor pipe insulation. In the case of fittings, pipe bends and other points where the weather-resistant jacket could not conveniently be applied, an asphaltic asbestos plastic coating was used instead.

Like indoor pipe insulation, indoor equipment insulation was finished with a pasted canvas jacket, cut back near hot metal surfaces to prevent scorching. Outdoor equipment insulation was coated with asphaltic asbestos plastic, applied over a layer of wire mesh.

FIRE YOUR GAS SAFELY

(Continued from page 77)

products of incomplete combustion may under certain conditions (as during a sudden change in firing conditions), form an explosive mixture with air and become ignited by a burner flame, a local hot surface or a spark. This type of explosion has been duplicated experimentally in small test installations. Obviously, flame-failure safeguards cannot prevent an explosion of this kind.

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Possible application of another type of device—a combustible recorder which continuously analyzes the flue gases—gives promise of successfully preventing explosions due to incomplete products of combustion while burners are operating, as well as those resulting from flame failure and the direct release of unburned fuel gas into the firebox. The device on installations would be arranged to sound an alarm before explosive conditions develop, and later, when it is proved reliable, to shut off the gas supply. The Factory Mutual Laboratories are working with the manufacturers to perfect, if possible, the details for its successful application.

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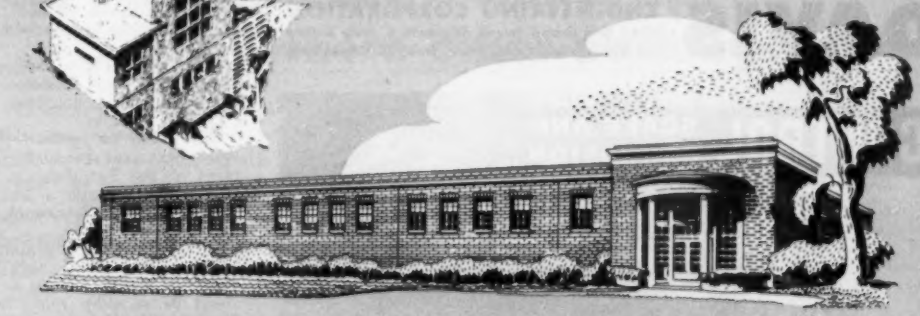

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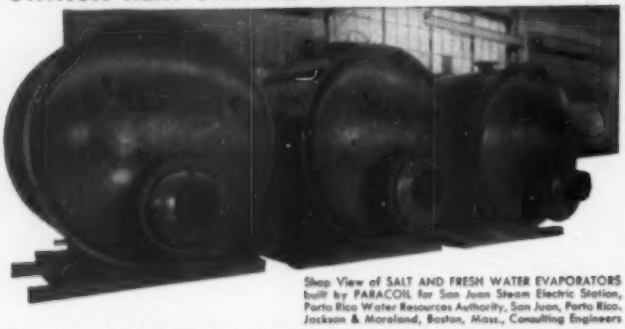

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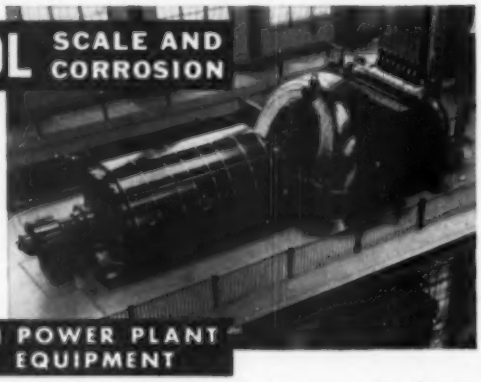

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LETTERS TO THE EDITORS

(Continued from page 53)

loss of the steam plant auxiliaries, and require a quick starting up of the steam auxiliaries.

One day, during the time of peak load, line trouble caused the sectionalizing switches to open at Mantica, and the same trouble cut off the telephone line to Stanislaus. Simultaneously, telephone connection between Mantica and Stanislaus was broken, cutting off Stanislaus from telephone communication with the rest of the system.

At the same time, the circuit breakers at Bay Shore opened, breaking the connection between Bay Shore and Mantica. Also, the tie-line between Bay Shore and the P.G. & E. system was cut off by the opening of another circuit breaker at Bay Shore.

The result was that the entire load of 43,000 kw was thrown on the North Beach Steam Plant, which had a maximum capacity of 27,000 kw. The excessive load on the North Beach station caused the frequency to drop and the increased load on the boilers similarly resulted in a drop in steam pressure. North Beach requested permission from the system dispatchers to drop part of the load. The dispatcher refused, ordering North Beach to hold on until normal operating conditions could be restored.

Due to the drop in frequency, the Sierra and San Francisco system could not be synchronized with the P.G. & E. system.

One 20,000 kw hydroelectric generator was available at the Kerchoff plant of the San Joaquin Light & Power Co. through a transmission line from Kerchoff through Modesto to Mantica.

Direct telephone communication between Bay Shore and Kerchoff was not possible, but a message could be sent by relay from Bay Shore to Mantica; Mantica to Modesto; and from Modesto to Kerchoff, one operator relaying the message to the next.

Kerchoff was directed to cut one generator off from the San Joaquin system and in on the Kerchoff-Modesto-Mantica line, which was cut in on the Bay Shore-Mantico section of the Bay Shore-Stanislaus line. Kerchoff was directed to lower its frequency until it overtook the still dropping frequency of North Beach. When this was accomplished, Bay Shore synchronized with the transmission line. Kerchoff was then directed to bring the frequency up to standard, at which time Bay Shore closed the tie-line with the P. G. & E. system. This was possible because North Beach plus Kerchoff totalled 47,000 kw, whereas the load was 43,000 kw.

When telephone communication with Stanislaus was restored, Mantica synchronized with Stanislaus.

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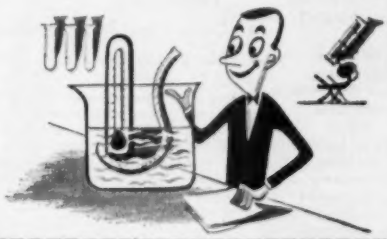

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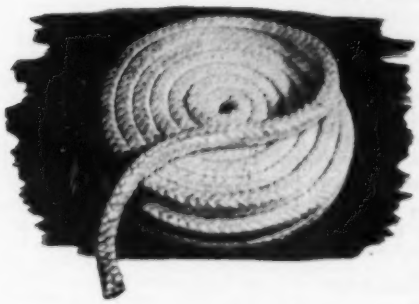

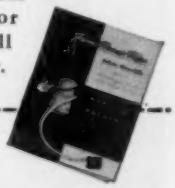

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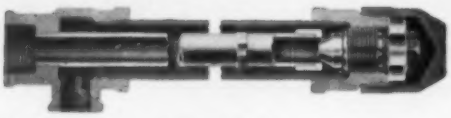

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these operations was 20 minutes, due mainly to the time required to relay messages from Bay Shore to Kerchoff.

I relate this experience to illustrate the type of operating problems that arise on Pacific Coast power systems where widely separated power stations are connected by long transmission lines. In a more compact area, distances are smaller, stations more numerous, and as a consequence different conditions exist. In the case just described, the auxiliaries at North Beach were not involved in the disturbance.
Los Angeles, Calif.

HOWARD T. LIVINGSTON

ASME FALL MEETING SEPT. 19-21 AT WORCESTER

THE AMERICAN SOCIETY of Mechanical Engineers will hold its Fall Meeting in Worcester, Mass., Sept. 19-21 at the Hotel Sheraton. Some 50 papers in such fields as heat transfer, management, rubber and plastics, textiles, power, machine design, safety, gas turbine power, fuels, hydraulics, materials handling, production engineering, metals engineering and wood industries will be delivered at 24 technical sessions. Appropriate to the New England locale, there will be four textile sessions. An ASME analysis of textile mill modernization will feature one of the sessions.

James D. Cunningham, president of the society, will speak at the President's Luncheon on the opening day of the meeting. The society will be welcomed by Mayor Andrew B. Holmstrom of Worcester, himself an ASME member. The Worcester Section of the society will act as host to the meeting. John Woodman Higgins, chairman of the board of the Worcester Pressed Steel Co., is general chairman of the Fall Meeting Committee.

Dr. James R. Killian, Jr., president of Massachusetts Institute of Technology, will be the banquet speaker, on Wednesday evening, Sept. 20. The Wood Industries Division of ASME will hold a luncheon the following day at which Nathan Tufts, vice president and general manager of the New England Box Co., Greenfield, Mass., will speak on "Words to Watch in New England."

Problems of conversion from coal firing to oil firing will be discussed at a combined fuels and power session. The safety, management and materials handling divisions of the society will cooperate to sponsor a technical session. Papers to be presented at the session will deal with building safety into textile machinery, dust hazards relative to grinding operations and the declining accident rate due to substituting machines for men in materials handling operations.

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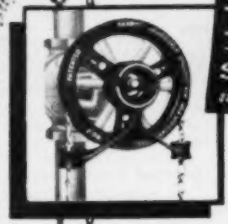

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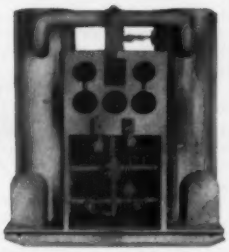

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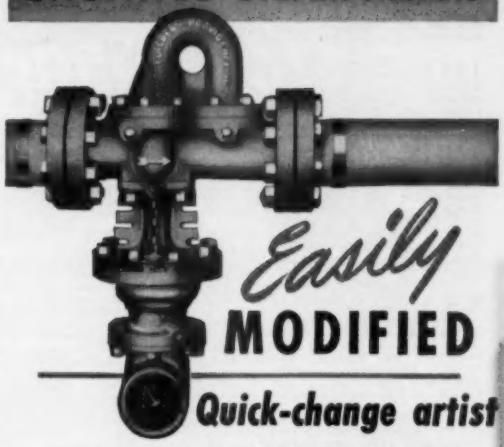
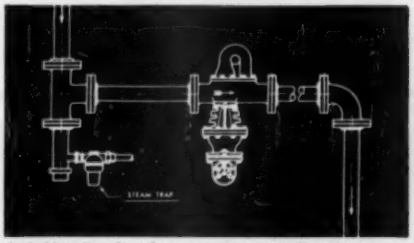
ANOTHER IMPORTANT FEATURE OF SHUNTFLO STEAM METER



Easily MODIFIED

Quick-change artist

Builders Shuntflo Steam Meter is easily modified for change in capacity. Simply remove the top cover, install a new orifice plate, and replace the cover . . . that's how easy it is to change from one capacity range to another. Many companies buy Shuntflo Meters with a complete set of orifice plates for checking steam, air, or gas consumption by individual machines, processes, departments, etc. Meters soon pay for themselves—they show accurately (within ± 2%) *where* the commodity is being consumed and *how much* . . . directly in pounds of steam, or cubic feet of air or gas. For engineering information and Bulletins 400-F1 and 400-F2, address Builders-Providence, Inc. (Division of Builders Iron Foundry), Providence 1, Rhode Island.



Method of installing Shuntflo Meter in horizontal offset of vertical main

Builders makes a complete line of flow meters and controllers for liquids, steam, air, gas, and dry materials . . . mechanical and differential . . . including The Venturi Meter and Chlorinizers (chlorine gas feeders).

BUILDERS PROVIDENCE Instruments

HELPFUL BULLETINS

(Continued from page 36)

OTHER EQUIPMENT

130 **For Easier Pinion Removal**—Form 13A162, 4 pp, introduces an induction pinion heater for removing pinions quickly and without damage. Photos illustrate the heater and show how it is used, and sketches show two methods of applying pressure. Advantages of heater's use are discussed; size, specifications included. National Electric Coil Co.

131 **Ion Exchange Systems**—"Amberlite Monobed Deonization" is a 12 pp miniature textbook covering the history, behavior, present performance, and potential uses of the Monobed ion exchange systems in water-conditioning, chemical processing and other industries. Reactions of the various combinations of exchangers are explained in text and equations. Also discussed are operating and equipment costs, quality of product derived, rinse requirements and other properties as they apply to the complete or partial single-step removal of ionized solids from solution. Design and operation of Monobed equipment is described and more than 80 fields of application listed. A table gives nomenclature, chemical behavior and typical uses of six different systems. The Resinous Products Div., Rohm & Haas Co.

132 **Rope Reference Chart**—This handy wall chart, 17 by 22 in., gives specifications on manila, nylon and sisal ropes. Diameters, circumferences, approximate net weight of 100 ft. and gross weight of full coils, breaking and working strengths, are included for sizes from 3/16 to 3-3/4 in. dia. Also explains company's dispensing carton and pre-measured marking feature. New Bedford Cordage Co.

133 **Power Plant Communication Systems** — This 25-pp brochure describes a high and low level intercom system designed and built especially for power plants—a system readily installed and permitting two-way conversations over close-speaking microphones and receivers (they look like ordinary telephone handsets) as well as paging over loudspeakers suited to different noise levels. Booklet tells what the system can do for your plant and includes photos of the equipment used. Also provides many views of a modern generating station in which this equipment is installed, showing its location in the central control room, turbine room, boiler firing aisle, and other places throughout the plant. Gai-Tronics Corp.

134 **Steam Jet Air Ejectors**—This 12-pp illustrated bulletin tells how company's steam jet ejectors work to remove air from condensers, explains ejector classification according to stages and discusses inter-stage and final-stage condensers. Also covers steam jets for special services, and air ejector accessories, and includes engineering data pertaining to use of ejectors in power and processing plants and in evaporators. Condenser Service and Engineering Co., Inc.

What Steam Jets Syphons Can Do —Steam jet syphons which operate on the jet principle utilizing energy of steam under pressure to pump, heat, mix liquids and handle solids are described and illustrated in color in Bulletin 2-A, 24 pp. In three sections, the first details the design, application, construction and operation of available types, with text supplemented by photos and drawings showing the operation and working parts. Sizes, dimensions, prices and capacities are presented in tabular form. Special purpose and corrosion resistant syphons are covered in Section 2. Typical applications of steam jet syphons in pumping, heating and mixing are included in Section 3. Schutte and Koerting Co.

136 **Double-Hung Refractory Arch**—The special advantages of company's pendulum-hung principle of supporting arches, now incorporated in a refractory hung insulated arch, are discussed in this single-sheet bulletin. Illustrates this design which permits freedom of movement without disengaging lower tiles and reduces mechanical spalling of refractories. George P. Reintjes Co.

137 **Handbook on Insulating Material**—Form G91051, 36 pp, tells the complete story on normal temperature applications of company's FC Foamglas insulation. Includes new information on its installation of floors-on-ground; the use of the materials as a wall lining for receting free-standing interior walls, and for ceiling insulation. Also contains technical data, facts about accessory materials available, description of trowel finishes for direct application. Pittsburgh Corning Corp.

138 **Selection Data on Lighting Fixture Hangers**—Catalog 50, 80 pp contains general and detailed information, including specifications, on disconnecting and lowering lighting fixtures, hangers, accessories, special devices and parts. Sectionalized for easy reference, photos and drawings show construction principles, operating features, typical installations, modifications and component parts for both indoor and outdoor units. Unit packages for diversified outdoor lighting are described. Shock absorbers, pulleys, rigid and adjustable suspension fittings are presented, as are details on new suspension yokes and concealed mounting units. The Thompson Electric Co.

CATALOG LIBRARY

(Continued from page 50)

sion resistant concrete are listed for many industries and also given, are the answers to questions often asked about it. Lumnite Division, Universal Atlas Cement Co.

277 **Corrosion Analysis**—Excellent working data on galvanic corrosion is contained in this 8-pp technical study of corrosion by concentration cells, reprinted from Inco Corrosion Reporter, Vol. 3, No. 1. Discusses concentration cells, the metal-ion cell type, oxygen cell type, reversible concentration cells, their practical aspects and some rules for minimizing or preventing concentration cell corrosion. Illustrated with sketches showing conditions which accelerate corrosion. The International Nickel Co., Inc.

278 **Technical Data on Plexiglas**—This is a file folder of technical and application information on Plexiglas sheets, rods and molding powders, covering their workability, physical properties, available thicknesses. Includes data sheets on the uses and advantages of Plexiglas in large area lighting, typical designs of coffers, photos of installation and a discussion of room lighting. Rohm & Haas Co.

279 **Wired Television**—Illustrated Bulletin 1025, 16 pp, introduces company's Utiliscope, a camera and monitor type of equipment designed to enable an observer to see where he can't look. Some of the many applications for this wired television which are described and illustrated include viewing instrument readings at remote points, checking boiler water levels, watching coal flow in chutes, watching hazardous laboratory tests, checking furnace ignition. Diamond Power Specialty Corp.

280 **Cleaning Industrial Equipment**—This is a general information bulletin on manufacturer's service for cleaning steam generating, heat exchange and other industrial equipment. Also included is information on pipe line cleaning and water well acidizing. Illustrations of these services are included, and bulletin treats in detail the methods used to remove incrustations from internal surfaces economically with minimum of downtime. Dowell Inc.

281 **Fluid Reduction Mills** — Bulletin 430-1, 8-pp, introducing company's fluid energy reduction mill, discusses the advantages of finer particle size in many processing operations. Illustrates the mill and explains its grinding operation. C. H. Wheeler Mfg. Co.

282 **Rotary Tube Cleaners** — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads, discussing special features. Also includes data on motors and hose for use with cleaners. Roto Div., Elliott Co.

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Must be experienced in power plant layout, piping, steel work, coal conveyors, and other power plant equipment, for employment in Milwaukee area. In your reply, furnish details on experience and qualifications, age, salary required, etc. Employment Office, Wisconsin Electric Power Co. 231 W. Michigan Street, Milwaukee 3, Wis.

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FOR SALE

2-CLASS A. No. 26 Chicago Automatic Stokers, almost new. High resistance boiler front and grates. Size 6' wide 8' deep. Stoker drive ½ H.P. 220 volts, 3 phase; Blower Drive 2 H.P. 220 volts, 3 phase. Master A. Jacks Stoker and Blower control unit. Used on 150 H.P. Kewanee boilers, capable of a 200% rating.

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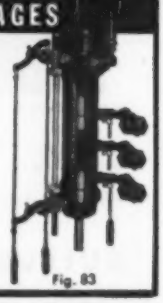

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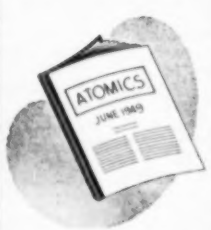
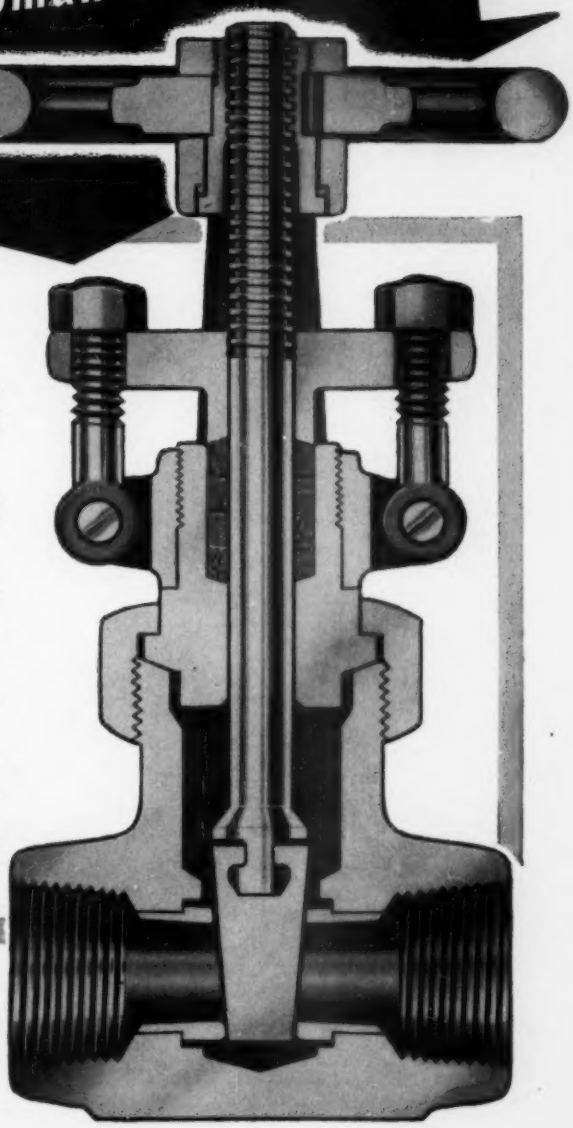


ATOMICS is published bi-monthly for engineers. The timely articles appearing in each issue are essentially practical in nature, written for the average engineer. A. W. Kramer, the editor of ATOMICS, has been a pioneer in interpreting and translating the complex, highly technical material issuing from the laboratory into language every engineer can understand. ATOMICS is the first regularly published journal of its kind. The issues sparkle with engineering data, news of atomic power, articles of timely interest to those concerned with industrial process control, practical material for men interested in the technical and engineering aspects of nuclear reactions.

ATOMICS - 110 S. Dearborn St. - Chicago 3, Ill.

Here's Why You Get Lower Maintenance Costs with Chapman List 960



1. *Gaskets!*
Available with either metal to metal or gasketed joint as required.

2. *50% Stronger!*
New design features compensate at points where excessive strain can develop . . . make stem and wedge gate connection 50% stronger than before.

3. *Wear-Resisting Wedge Faces!*
To keep your maintenance cost down the wedge faces are hardened to 800 Brinell by the exclusive Malcomizing process.

4. *Replaceable Seat Rings!*
When necessary, you can replace the seat rings easily . . . fast. Seat rings have wear-resisting and non-galling properties . . . made extra hard for years more service.

5. *Full Pressure Repacking!*
No need for costly interruption of flow to repack.

But check this lower maintenance cost for yourself. Next time you buy specify List 960 in sizes from ¼" to 2". Rising stem with yoke (as illustrated) or rising stem inside screw type. For pressure range 2000 lbs. at 100 deg. F., 380 lbs. at 1000 deg. F. Specify List 990 for higher pressures.

The CHAPMAN Valve Manufacturing Company

INDIAN ORCHARD • MASSACHUSETTS

You can SAVE MONEY
REDUCE SILICA with the
Permutit® Sludge Blanket Hot Process!
here is a typical case history
A leading paper plant recently installed a Permutit Sludge Blanket Hot Process water softener. The results of several years' operation have been entirely satisfactory. Silica in the boiler feed makeup was reduced to 1/5 the amount previously obtained with a conventional type softener.
Look at the following figures, and you won't wonder that the plant's estimated annual savings on treating chemicals exceeded $6,000!
CHARACTERISTICS
Conventional Design
Sludge Blanket Design
Silica in raw water, as SiO_2 ppm 55 55
Silica in effluent, as SiO_2 ppm 11 2.0
MgO feed, ppm 76 59
Parts SiO_2 removed per part MgO 0.6 1.1
Average retention time of $Mg(OH)_2$ in hours 4.7 100
Contact time of water with $Mg(OH)_2$ in minutes 92 87
Hardness of effluent, as $CaCO_3$ ppm 21 15
Average load on softener, % rated capacity 65 46
Temperature in softener 220°F 243°F
The Permutit Hot Process offers your plant other benefits as well: More efficient use of magnesia! Longer filter runs! Lower turbidity in settling tank effluents! Greater adaptability to flow rate fluctuations! Here indeed is another achievement that spells "Permutit Leadership in Water Conditioning!"
Write for full information to the Permutit Company, Dept. P.E.-9, 330 West 42nd Street, New York 18, N. Y., or to the Permutit Company of Canada, Ltd., Montreal.
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Water Conditioning Headquarters
Permutit Products for Power Plants
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